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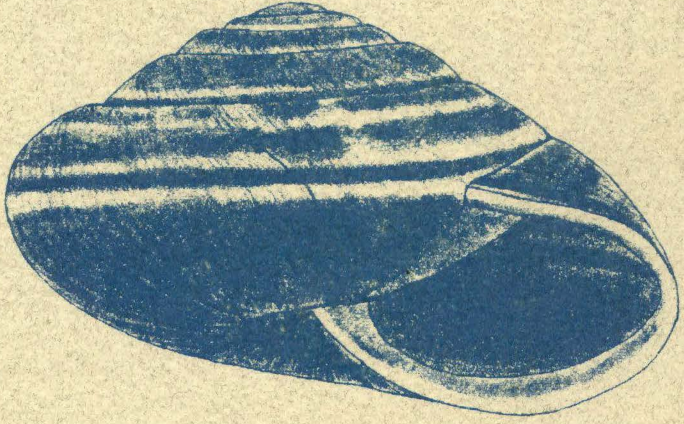
# MOLLUSC SPECIES OF SPECIAL CONCERN WITHIN THE RANGE OF THE NORTHERN SPOTTED OWL



Dalles sideband *Monadenia fidelis minor* (Binney, 1885), x 4

## FINAL REPORT

Prepared for:

Forest Ecosystem Management Working Group
USDA Forest Service
Pacific Northwest Region
Portland, OR

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May 1, 1993

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# MOLLUSC SPECIES OF SPECIAL CONCERN WITHIN THE RANGE OF THE NORTHERN SPOTTED OWL

## with an ADDENDUM addressing new management options proposed in June, 1993

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# MOLLUSC SPECIES OF SPECIAL CONCERN WITHIN THE RANGE OF THE NORTHERN SPOTTED OWL

## INTRODUCTION

Listing of the Northern Spotted Owl as Threatened under the Endangered Species Act has provoked an intensive effort to thoroughly assess the biological and economic impacts of the action. It was clear from the beginning that the issue involved more than a single species. The future, utilization, management, and conservation of the old growth and late successional forests of the Pacific Coast states and their associated biota were the real subject. In the last few years, labors to formulate a Recovery Plan (USFWS, 1992a, b) have been unusually comprehensive and exhaustive. Early on, it was deemed desirable to address ecosystem concerns as part of that process. As a result, assessment of the old growth and late successional forest ecosystem was attempted on a large scale. This involved some consideration of certain key invertebrate groups. As part of that effort, we were asked to determine mollusc species of special concern occurring within the range of the Northern Spotted Owl, and submitted a brief report on the subject (Frest & Johannes, 1991b). Results from this report were included in the draft and final draft Northern Spotted Owl Recovery Plan (USFWS, 1992a, b), and also in the report of the Scientific Analysis Team (SAT hereafter: Thomas *et al.*, 1993). Subsequent to the Forest Conference of April, 1993, the Forest Ecosystem Management Working Group asked us to participate (with Dr. Barry Roth) in a panel to make viability assessments for, and determine effects of, various management options on molluscs in publicly-owned old growth and late successional forests. To complete this undertaking we reviewed and revised the 1991 report to reflect new information; we also expanded it to cover the somewhat different mandate of the viability panel.

This document is thus intended to serve several purposes. It attempts to provide an overview of, and draw attention to, the Pacific Coast states' mollusc fauna and its role in the old growth-late successional forest ecosystem. It also identifies species known presently to be in some risk of extinction within the range of the Northern Spotted Owl (Tables 1, 2). We here emphasize those species known to occur on public lands (particularly those managed by USDA Forest Service and USDI Bureau of Land Management [BLM hereafter]: Table 1), and hence subject to the provisions of the Forest Management Act of 1976. Short species discussions summarize information on ecology, distribution, and Forest Service and BLM sites with each species. Evaluations of management and viability options are made (Table 3); and recommendations for status of these taxa under State and federal endangered species rules are provided (summarized in Table 2). We hope that this report will aid in effective federal and state management of these extraordinarily interesting species. Time constraints make it necessarily somewhat summary and telegraphic; additional information is often available from the authors and from other sources.

## LAND SNAILS AND SLUGS

### Background

Over 150 species of land snails and slugs have been ascribed to or described from western Washington and Oregon and northern California. After a period of relative quiescence, the pace of discovery and description of new forms has picked up, and it is quite likely that the land snail and slug fauna will eventually more than double. The slug fauna of about two dozen species is extraordinary, and unmatched anywhere else in North America. Many of the land snail genera occur only in western North America west of the Rocky Mts.; the fauna is thus sharply distinct from that of the rest of the U.S.

Land snails can be found at any elevation and in all situations from coastal lowlands to arid deserts, if the area is relatively undisturbed. Generally, there are two main groupings, one composed of small (<2 mm) species and the second of larger forms (often to several cm in diameter). Small species, though seldom noticed, are most ubiquitous, as their small size makes concealment from predators and retirement in adverse conditions most practical. At the highest elevations (tundra-like habitat), only small forms are found. At lower elevations, both large or small forms may be present. There is some suggestion of altitudinal speciation in some genera, likely more due to responses to differences in effective precipitation and temperature than to height *per se*. Many areas favored by land snails share common features. Most significant are cover, effective moisture availability, and geologic history. Geologically distinctive regions, such as the Klamath Province (Siskyou and Klamath Mts, southwestern Oregon and northwestern California: Figures 2, 3) often have high diversity and many endemics. This is partly due to molluscs' substrate preferences. For example, a large proportion of the eastern U.S. land snail fauna is calciphilous, found only on limestone, dolomite, and similar lithologies and soils derived from them. Edaphic conditions are likely controls for many western species as well. Land snails are typically very rare, for example, on granitic terrains. Western snails can tolerate moderately acid conditions; but faunas are more diverse (and, often, individuals are more abundant) on soils with slightly alkaline pH. Some larger species, such as the candidate *Monadenia troglodytes troglodytes*, may occur only in limestone areas.

The biology and role of land snails and slugs in the forest ecosystem is closely similar to that of many arthropods (see Olson, 1992 for background). In general, land snails in this region (as elsewhere in North America) require relatively undisturbed cover. Most are somewhat retiring, and avoid areas with strong insolation or exposure. Many cease activity and shelter during dry or exceptionally cold or hot periods. At some times in the year, land snails are most active from dusk to dawn. Genera such as *Monadenia* may be strongly eoan and/or crepuscular; others, such as *Vespericola* and many slugs, may be quite active in daylight. Activity and visibility often increase markedly after rain storms. Most thrive in lowland to middle elevation moist (often riparian) forests and the areas around springs, bogs, or marshes. Rocky taluses or rockslides are another favorite habitat; these may be occupied regardless of cover, but the snails may be difficult to find except under special weather conditions. In this region, occurrences in basalt or limestone taluses are frequent. Coastal areas, because of their relatively high humidity, are another favored area of occurrence. Minor differences in insolation, cover, or availability of moisture, even on the same slope, may result in very different land snail communities (*e.g.*, Roth & Eng, 1980). Thus, colonies can be very local.

Regardless of major habitat type, desiccation is the primary reason for land snail mortality even in undisturbed habitats (Solem, 1984). Snails and slugs in each major habitat type have evolved ways of dealing with the problem. Talus-dwellers are often cryptic for most of the year. Most snails shelter or aestivate even in dense forests in the typically dry period from June-August; many hibernate in winter. Snails and slugs frequently shelter under leaves, bark, litter, or logs. Some *Monadenia* individuals shelter in moss on trees far above the ground. Even snails more tolerant of xeric conditions need rocks or loose plant material of some size and volume for diurnal and seasonal shelter. Suitable winter or long-term retreats (hibernaculae) are uncommon, and may be occupied over many years and by large numbers of individuals. Thus ready availability of coarse woody debris is very important for forest molluscs, as it is for many other forest-dwellers (see Harmon *et al.*, 1986 for a general review ; Spies, Franklin, & Thomas, 1988 for Douglas fir forests). The lack of shells and special modifications of the slime enable slugs to shelter and move about more readily than most shelled forms. Most land molluscs do not travel far from their place of birth unaided, and dispersal is relatively slow. Colonies may contain thousands or hundreds of thousands of individuals. Viable colonies, particularly of the small forms, may occupy areas of only a few tens of square feet; colonies of larger forms are correspondingly larger, but viable sites may be only a few hundred square feet in area. Densities in colonies vary considerably from species to species. *Monadenia* adults may be rather sparse (Roth & Eng, 1980). Small forms can have hundreds of individuals in a 1 square foot area.

In general, any modification of habitat that decreases available moisture or increases insolation is very strongly detrimental to land molluscs. Logging tends to increase insolation to the point that most species are extirpated. Burning of slash, physical disruption of habitat, and destruction of forage plants (often deciduous trees and shrubs and herbaceous forest understory) compounds the problem. Indirect effects, such as stream modification and destruction of springs, have removed much additional habitat, as has human settlement along the coast proper. Tree farms, like Midwest corn fields, are generally devoid of any native mollusks. Sometimes, only introduced species, like most commonly seen garden slugs on the West Coast, may thrive in such settings. In our study sites in western Washington, for example, relatively undisturbed sites had a mean diversity of 10-12 species. Recently clear-cut areas generally had no shelled species. Most areas that had been clear-cut 20-60 years ago regained no more than 2 shelled species. Often, the only molluscs seen alive in recent clear-cuts were found in very limited colonies under protected settings, such as missed trees or unburned debris piles. In our opinion, the long-term viability of such colonies is questionable, let alone their ability to serve as reservoirs to repopulate regrown forests. Generally, only one or two slug species were at all widespread in recent clearcuts or in reforested areas up to 40 years after cutting. Land and freshwater molluscs are also quite susceptible to the effects of forest spraying for pest and unwanted plant control.

Grazing is also a major factor causing extirpation. Direct trampling is the major problem, but resulting vegetation changes and the usual reduction in plant biomass and effective cover are also significant. Most known sites for the genus *Hemphillia* and many other of the Asian-derived or -affiliated endemics have been destroyed by logging of lowland old growth; many species of special concern seem to be specifically associated with such forests (Table 2). Many species are now or were originally very limited in distribution. The Malone jumping slug, *Hemphillia malonei*, *e.g.*, occurs only on the slopes of Mt. Hood. Many species of *Monadenia*, *Vespericola*, and allied genera in northern California have strongly circumscribed ranges. The genus *Megomphix* has similar problems; all known sites for *hemphilli*, *e.g.*, were either in the Puget Sound region or in the more or less completely cut-over Willapa Hills, southwestern Washington. Both *leutarius* and *californicus* have very limited ranges. Very few sites for this genus have been found in recent years, and the whole family Megomphicidae is now quite rare; some southern California species have been previously suggested as Federal listing candidates. Management of Pacific Coast state forests should reflect such considerations if survival of the native land mollusc fauna is to be assured.

A recent study (Frest & Johannes, 1993c) of one western National Forest may be instructive: studies of Eastern Deciduous Forest land snail communities may not be directly relevant. The Black Hills National Forest, South Dakota and Wyoming, is dominated by Ponderosa pine and spruce forests. Much of the area with pine cover has been logged recently, and very little intact riparian vegetation remains. Grazing is common on logged terrain and in lowland areas. Large areas were mined long ago, and some operations continue. Forest fires are common and destructive. Survey of 189 sites by a combination of litter sampling and live collecting yielded some interesting results. Thirty-six species were found to remain in the Forest. A few were new taxa; these included uncommon local endemics and habitat-restricted forms; but the bulk of the fauna was of forms widespread in North America. A number of species previously reported from the area were not found.

Heavily logged and grazed sites had a very small land snail and slug fauna consisting of about six widespread forms. Areas that had been clear-cut did not appear to recover their snail fauna, even after many years; upland areas were particularly hard-hit. Mined localities were similarly affected. Fires occurring before fire suppression was attempted seem to have had only local effects on the land snail fauna; modern fires effectively sterilize large areas of snails. The native freshwater mollusc fauna of the Forest appears to have been almost entirely extirpated, even from spring habitats. Even relatively widespread species have been extirpated from most or all of the Black Hills. The richest areas for diversity were the few remaining relatively intact riparian areas and limestone canyons with spruce cover, in part because logging of spruce does not take place. Such sites commonly had diversities of fifteen or more species. Well over half of the total number of species were confined to a small area in the northwest part of the Forest and occurred at only a few sites. Because of extensive habitat loss, several species were suggested for federal listing, and protection of the few remaining sites for most was strongly recommended.

Land snails and slugs are mostly herbivores; a few will also consume animal matter of various kinds, and fewer still (*Ancotrema*, *Haplotrema*) are carnivores, particularly of other snails. The small forms generally eat partly decayed leaves and plants and fungi upon them. Leaves from deciduous trees and shrubs (*e.g.* , *Salix*, *Alnus*, *Populus*, *Acer*, and *Cornus*) are particularly liked. Some slugs and snails relish larger fungi. More often, green vegetation in the understory is preferred (examples include *Heracleum*, *Rorippa*, *Rubrus*, and even *Urtica*). Such shelled genera as *Allogona* and *Vespericola*, as well as many slugs, seem to commonly consume green vegetation; but all larger molluscs also eat fallen leaves. Some genera (*e.g.*, *Monadenia*) prefer fallen leaves or inner bark layers. Juvenile and adult feeding preferences may differ (Roth & Eng, 1980; personal obs.). They are thus primary higher plant recyclers in forested situations. In turn, snails and slugs are consumed avidly by many small mammals (*e.g.*, shrews, voles, shrew moles) and by a number of birds. Various insects, including certain beetle, fly, and wasp families, either prey upon snails directly or parasitize them with their eggs and larvae. Snail shells are used for shelter, domiciles, or egg-laying sites by a variety of insect and other arthropod taxa. Certain of the larger land snails were even utilized as food by Native Americans.

Willows Alders Poplars Maples Dogwood

Life history of many taxa is strongly controlled by climate. Nearly all of the small species have one-year life spans and are semelparous. Breeding may take place in the spring, after snow melt, or somewhat later in the fall, especially September-October. Eggs hatch about one month after being laid, and some adults and many young survive the winter. Larger land snails are more variable. Some species of *Monadenia, e.g.*, may live for at least 8-10 years; sexual maturity may be reached in these species in two to three years (Walton, 1970). *Vespericola* and *Cryptomastix* appear to have a much shorter life span, perhaps two years or less for most species. Life span may differ between talus dwellers and forest species in the same genus; this has not yet been carefully investigated. The land snail genera *Allogona*, *Ancotrema*, *Cryptomastix*, *Haplotrema*, and *Monadenia* have been observed copulating most frequently in the period from April to June. Eggs and juveniles of the same genera have been seen most often from May to July. Under suitable conditions, egg laying may also take place in some forms in fall. Certain taxa, such as *Prophysaon*, are most likely to reproduce in the period from September to October. Mortality is heavy in the summer and winter. Certain slugs and shelled forms have similar life cycles; however, at least some genera are iteroparous, and some have life spans greater than one year. As in freshwater molluscs, adults of small forms may die after laying eggs. The larger forms breed and lay eggs in much the same seasons as do the small species; but some genera appear to breed in only one season (or once per year), generally in the spring. In these taxa, adults need not commonly die from reproductive stress. Brood sizes may vary considerably from taxon to taxon. Seasonality of activity, including reproduction, is most strongly pronounced in open-ground, xeric, or talus habitats, and is much less so in perennially-moist environments. While available moisture at certain times is vital, species and genera vary widely in their moisture tolerances. Some forms (*e.g.*, *Vespericola*, *Prophysaon* , and *Hemphillia*) are found only or largely in perpetually very moist areas, often riparian forests or spring and seep borders. Others (*e.g.*, certain *Monadenia* and *Oreohelix* species) avoid extremely moist situations. Acid habitats such as bogs often have relatively low diversity faunas, with few large taxa. High diversity is frequently associated with calcareous habitats.

## Land Snail Biogeography

Many of the land and freshwater mollusc (bivalve and snail) taxa currently living in the West Coast states have very limited geographic ranges. Part of the current land snail fauna, for example, consists of relatively recent (perhaps 65 million years B.P.) immigrants from Asia, or forms derived from Asian ancestors and not present elsewhere in the U.S. Even in such widespread families as the Polygyridae, western forms are generally distinct at the generic level (*e.g.*, *Vespericola* and *Cryptomastix vs. Mesodon* and *Triodopsis*). Characteristic coastal forms are different from those of the Rocky Mts. (*e.g.*, *Monadenia vs. Oreohelix*) . Most such taxa are confined to a coastal belt that extends only from the Cascades to the Pacific. Within the Northern Spotted Owl's range, there are three distinct land snail provinces widely recognized by malacologists (Pilsbry, 1948, with

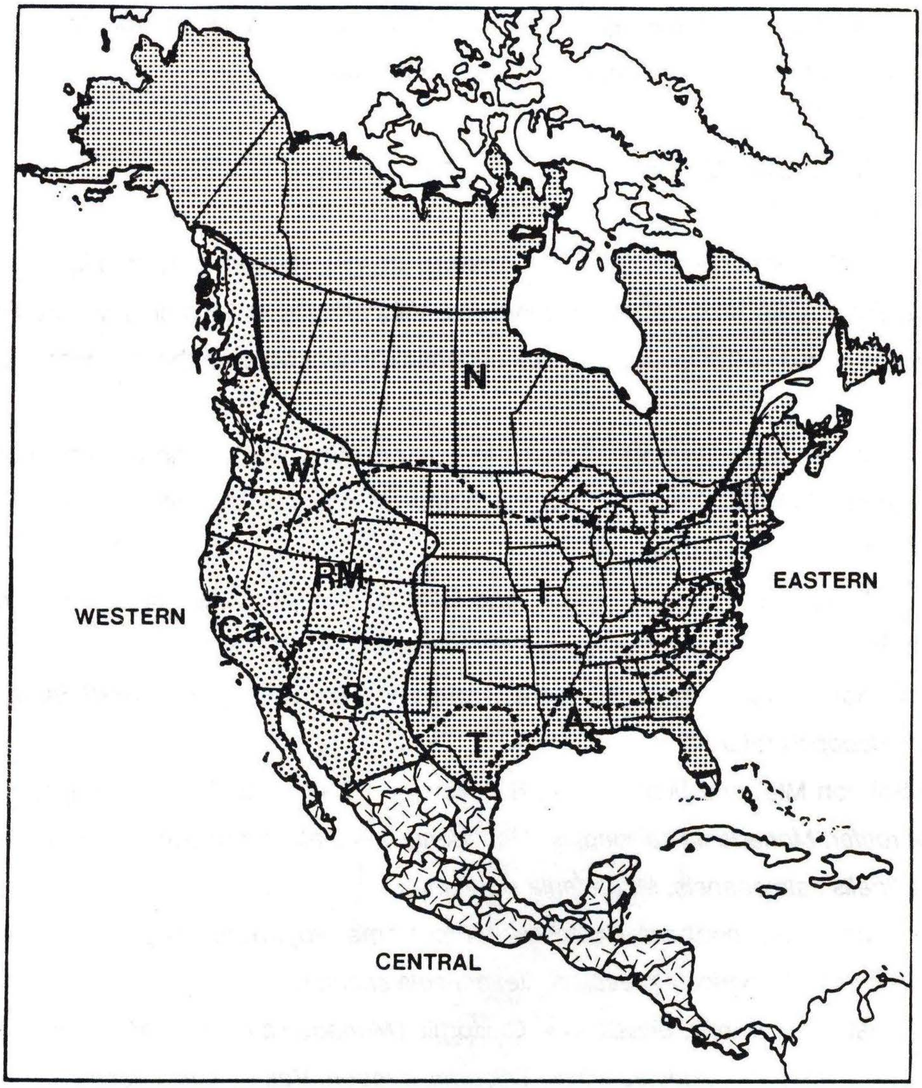

FIGURE 1. LAND SNAIL BIOGEOGRAPHY IN NORTH AMERICA.

Modified from Pilsbry (1948)

Regular stipple: Eastern North American Division

| | | | |
|---|---|---|---|
| N- | Northern Province | I- | Interior Province |

Irregular stipple: Western North American Division

| | | | |
|---|---|---|---|
| W- | Washingtonian Province | O- | Oregonian Province |
| Ca- | Californian Province | S- | Southwestern Province |
| RM- | Rocky Mountain Province | | |

modifications: Figure 1 herein). The Oregonian extends from coastal British Columbia just into extreme northern California; the Washingtonian extends east from the Cascades crest to Idaho; the Californian is coastal from northern California just west of the Nevada border to Baja California. Each of these provinces is discriminated at the generic level.

## Areas with High Diversity or Endemism

There are sizable endemic species clusters in the shelled genera *Helminthoglypta*, *Monadenia*, *Trilobopsis*, *Megomphix*, *Haplotrema*, *Vespericola*, and the slug genera *Prophysaon* and *Hemphillia*. Some of the most significant endemic clusters occur in the following areas (Figure 2):

1) the western Cascades and Olympics in western Washington and extreme northwestern Oregon (examples include various *Hemphillia* and *Prophysaon* species, *Cryptomastix devia*, *Megomphix hemphilli*, *Vertigo* n. sp. 1);

2) the Columbia Gorge, Washington and Oregon (*Vespericola depressa*, *Cryptomastix hendersoni*, *Monadenia fidelis minor*, *Hemphillia malonei*);

3) the Shasta River canyon, northern California (*Helminthoglypta hertleini*, *Monadenia chaceana*, *Trilobopsis tehamana*);

4) the Salmon Mts. and Marble Mts., Siskiyou Co., California (*Helminthoglypta talmadgei*, *Monadenia rotifer*, *Monadenia callipeplus*, *Monadenia cristulata*, *Monadenia fidelis ochromphalus*, *Monadenia fidelis salmonensis*, *Monadenia scottiana*);

5) the Trinity Mts., northern California (*Ancotrema voyanum*, *Megomphix californicus*, *Monadenia setosa*, *Vespericola pressleyi*, *Vespericola shasta*);

6) Mt. Shasta and vicinity, Shasta Co., California (*Monadenia churchi*, *Monadenia troglodytes troglodytes*, *Monadenia troglodytes wintu*, *Trilobopsis roperi*, *Vespericola shasta*);

7) lower Klamath River, Humboldt Co., California and adjacent Oregon (*Monadenia fidelis klamathica*, *Monadenia fidelis leonina*, and *Vespericola karakorum*);

8) northern California coast, Mendocino, Humboldt, and Del Norte cos, California (*Helminthoglypta intercessa*, *Vespericola eritrichius*, *Vespericola euthales*, *Vespericola marinensis*);

9) southern Oregon coast, Curry Co., Oregon (*Monadenia fidelis pronotis*, *Monadenia fidelis flava*, the genus *Hochbergellus*);

10) lower Rogue River valley, Oregon (*Helminthoglypta hertleini*, *Monadenia fidelis celeuthia*).

Other endemic clusters are likely in the Siskiyou Mts., Oregon, and in the lower Umpqua River valley, Oregon. Undiscovered species are most likely in the Oregon Klamath, California Klamath, and California Coast Provinces.

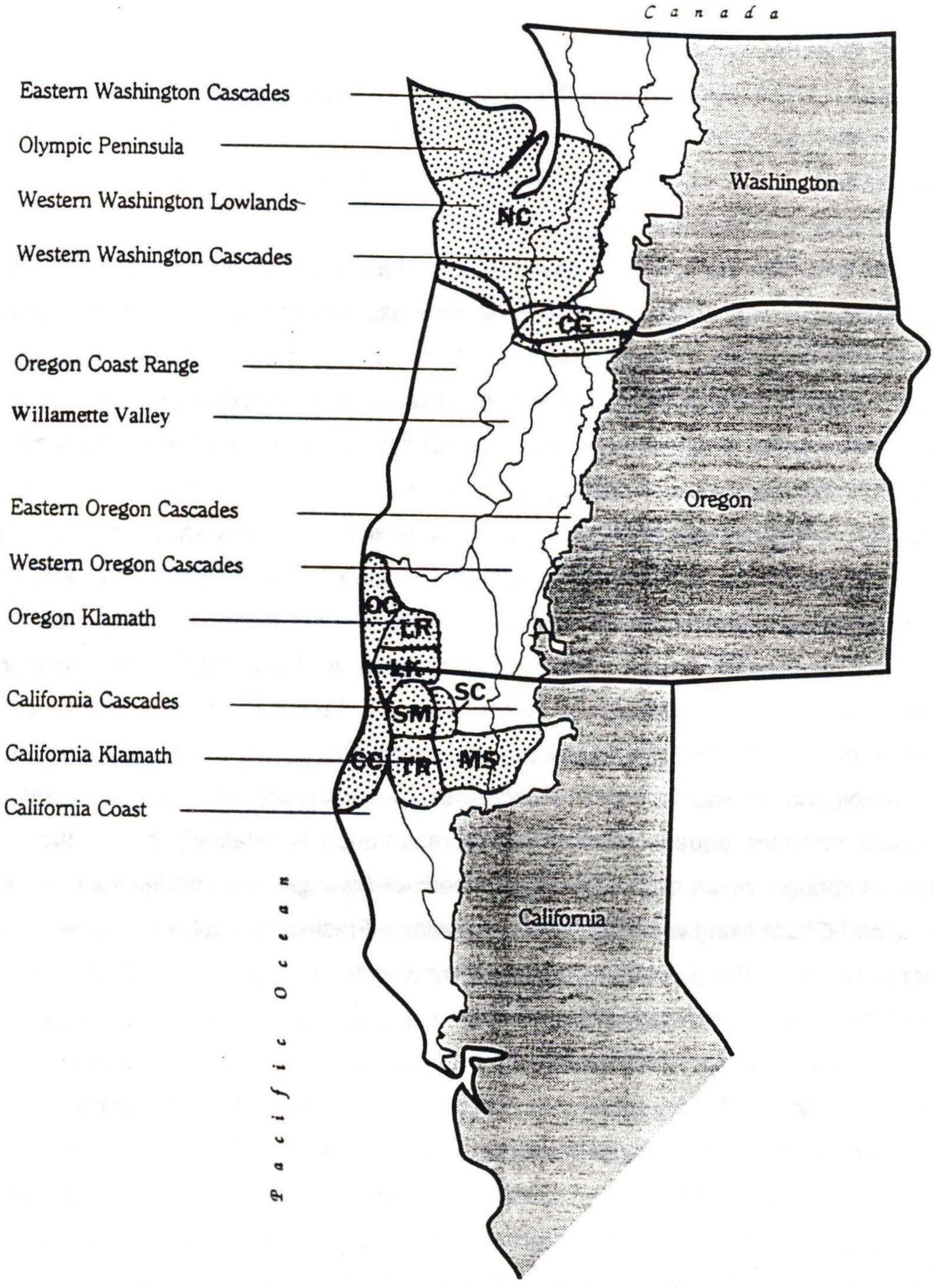
Canada
Eastern Washington Cascades
Olympic Peninsula
Western Washington Lowlands
Western Washington Cascades
Oregon Coast Range
Willamette Valley
Eastern Oregon Cascades
Western Oregon Cascades
Oregon Klamath
California Cascades
California Klamath
California Coast
Washington
Oregon
California
Pacific Ocean
NC
CG
OC
LR
LK
SC
SM
CC
TR
MS

FIGURE 2. AREAS OF LAND SNAIL ENDEMISM WITHIN THE RANGE OF THE NORTHERN SPOTTED OWL.

| | | | |
|---|---|---|---|
| NC- | North Cascades and Olympics | CG- | Columbia Gorge |
| SM- | Salmon and Marble Mts. | SC- | Shasta River canyon |
| TR- | Trinity Mts. | MS- | Mt.Shasta and vicinity |
| CC- | California coast | LR- | lower Rogue River valley |
| OC- | Oregon coast | LK- | lower Klamath River valley |

# FRESHWATER MOLLUSCS

## Background

To date, over 200 species of freshwater snails have been described from western North America. In recent years, the pace of taxonomic work has accelerated. It is likely that the total will exceed 400 in the next 20 years. About 30 freshwater bivalves occur west of the Rocky Mountains. Included are about 10 larger mussels (Unionidae, Margaritiferidae, and Corbiculidae), plus approximately 20 so-called fingernail clams (Sphaeriidae). A few bivalve taxa remain to be described; but the vast majority have long been known.

Freshwater molluscs can inhabit permanent water bodies of all sizes. Some few can either tolerate or are adapted specifically for conditions in temporary or seasonal situations. Flowing-water situations are generally places of high diversity for both clams and snails, but lakes, in particular river lakes or spring-influenced bodies such as Clear Lake (Lake Co., California) or Upper Klamath Lake (Klamath Co., Oregon), may have exceptional faunas. In the Pacific Coast states, abundance and diversity are often highest in clear, spring-fed streams or large spring pools with cold, well-oxygenated water and stable cobble-boulder substrate. At many sites preferred by West Coast molluscs aquatic macrophyte representation is relatively minor; the common exception is springs, which may have dense stands of flowing-water species such as *Rorippa*, *Veronica*, and *Cicuta* along with huge snail populations. Freshwater molluscs can be found at all elevations; however, there is little tendency toward altitudinal speciation. Endemism is most frequent in springs and spring-fed streams, regardless of size. There are few if any endemic freshwater forms in temporary water bodies. Most endemics occur at low or moderate elevations, regardless of habitat. The candidate Rocky Mountain limpet *Acroloxus coloradensis* is an exception; and there could be undiscovered species with similar habitat preferences in the alpine lakes of the Pacific Ranges as well. In streams, it is quite common for species compositions and dominances to change radically from the headwaters to the mouth. Endemic headwaters and large stream forms are frequent. Because of historic factors (discussed below), the freshwater mollusc faunas of larger systems are often not uniform, with particular species and even genera occurring either sporadically throughout or only in certain parts of the system, despite identical habitat being present elsewhere. High-gradient streams often have small and generalized freshwater mollusc faunas, as do areas with mobile substrate. Streams with glacial flour (*e.g.* Hood and Klickitat rivers, Washington & Oregon) often have small faunas composed only of widely distributed forms.

Prior to human modification -and to an extent still- many Pacific Coast streams provided exceptional mollusc habitat. River conditions historically were exceptionally favorable in the Sacramento, Columbia, Lahontan, and Klamath systems. The very large spring complexes of the Sacramento, Columbia Gorge, and Lahontan drainages also constitute extraordinarily favorable freshwater mollusc habitat. While lotic habitats are comparatively common in the region, lentic sites are more limited. Notable are the large spring pools of the lower Pit River, California and the large spring-influenced lakes on the east periphery (Upper Klamath Lake, Lower Klamath Lake, Tule Lake, Goose Lake, Pyramid Lake, Lake Almanor, and Eagle Lake). In more than half of these, the native and endemic freshwater mollusc fauna has been seriously impacted or extirpated.

Most North American freshwater mollusc species are sensitive to pollution (Burch, 1989) regardless of source. Relatively few species tolerate warm waters, low dissolved oxygen, or major seasonal fluctuations. Certain pulmonates in the families Physidae, Lymnaeidae, and Planorbidae and some sphaeriid species are major exceptions. Most native Pacific Coast forms, however, are cold-water stenotherms. Such species prefer clear and cold, unpolluted waters with dissolved oxygen (DO) levels near saturation. The cold-water forms are quite sensitive to hypoxic or anoxic conditions, in either the water column or substrate: again, certain lymnaeids and sphaeriids and a few unionaceans are the major exceptions. Very few clams or snails can tolerate algal blooms or dense macrophyte stands; they avoid or are excluded from areas with major diurnal DO fluctuations.

Trophically, most Pacific Coast freshwater snails are primary plant consumers. They are typically grazers, largely of aufwuchs (mostly attached diatoms, bacteria, and smaller epiphytic algal taxa) on stones. The majority are obligate perilithon feeders; a few can also graze periphyton, and a small number can also feed upon larger aquatic macrophytes. A few species, notably including *Valvata humeralis* Say, 1829, *Helisoma (C.) newberryi* (Lea, 1858), and some *Juga* species, are obligate or facultative detritivores, often occurring on or in oxygenated mud substrates. Feeding abilities vary from species to species. Some *Juga*, for example, can eat infallen waterlogged deciduous tree leaves.

Certain freshwater snail species may be especially sensitive to disturbance. The Pacific Northwest endemic family Lancidae, for example, lacks either lungs or gills and has modified the shell shape into a limpet-like form. Respiration is accomplished entirely through the mantle; and all species seem especially sensitive to DO fluctuations or to hypoxic or anoxic conditions. The Upper Sacramento drainage form *Lanx patelloides* (Lea, 1856) is one example; the Upper Klamath Lake form *Lanx klamathensis* is another. Many other Pacific Coast snails belong to the hydrobiid genera *Fluminicola* and *Lyogyrus*. While tolerances of the family vary considerably, these small snails are often rather sensitive to pollution, siltation, warming, and hypoxia. They inhabit a variety of lentic and lotic environments, generally with cold, clear water, often flowing, high DO, and rocky substrate. Springs and spring-influenced habitats are especially favored. At least half of the Pacific Coast endemic freshwater taxa are Hydrobiidae in these two genera.

The freshwater clams, large and small, are filter feeders, extracting diatoms, other unicellular organisms including bacteria, and fine organic detritus from the water column. The larger bivalves are mostly very sensitive to low oxygen conditions and responsive to changes in water chemistry. Unionaceans accumulate heavy and transition elements in their tissues when they are present in ambient water. They also may filter out and retain organochloride herbicides, pesticides, and certain viruses. For all three substance classes, held concentrations can become autotoxic. Clams filter very large quantities of water, and eventually are also sensitive to low or fluctuating DO. However, freshwater bivalves' ability to lower their metabolic rate and close their valves in response to unfavorable conditions gives them some protection from event disturbances. Environmental tolerances of sphaeriids vary considerably. Many are relatively pollution and disturbance-tolerant, but a few are comparatively stenotopic cold water species (*e.g. Pisidium (C.) ultramontanum* Prime, 1865, *Pisidium (N.) punctatum* Sterki, 1895). Most unionaceans prefer sand-gravel substrate, while many sphaeriids prefer mud-fine gravel.

Oligotrophic mountain streams and springs are particularly prevalent as aquatic habitat in the Pacific Coast states. A number of freshwater species are specifically adapted to this environment. These have been termed "cold water biota" in Idaho; they are of especial interest in that many of the state's endemic and Threatened and Endangered taxa fall into this group. Preservation of cold water biota is a designated major goal of state water quality regulations in Idaho; one would hope that the Pacific Coast state and federal jurisdictions will do likewise. Five such taxa from the middle Snake River have recently been added to the Endangered Species list (USFWS, 1992d), after extensive study (Frest & Johannes, 1991a, 1992a, b, c; 1993a, b). Habitat characterization for these taxa is the same as that for many Pacific Coast forms: "[a]ll require exceptionally well-oxygenated, clean water. They are currently restricted to areas with unpolluted, cold, clear, flowing water, and are intolerant of impoundments; turbid water; slack water; water with substantial quantities of dissolved herbicides, pesticides, nitrates, or phosphates; water with substantial quantities of suspended fine sediment; habitats with unstable substrate, regardless of particle size; hypoxic conditions, regardless of cause; and areas subject to frequent water level fluctuations. None are typically river-edge [amphibious] or lentic species; all prefer lotic habitats" (Frest & Johannes, 1992b, p. 8). Of the freshwater taxa listed in Tables 1-3, the following likely fall into the cold water group: all *Juga* species; *Pyrgulopsis species*; all *Lyogyrus* species; all *Fluminicola* species; the species of *Lanx* ; *Fisherola nuttalli, Helisoma (C.) newberryi*; the *Vorticifex* species; the larger bivalves; and *Pisidium (C.) ultramontanum.* The Idaho taxa are all lotic forms; but a few Pacific Coast taxa are lentic or can occupy both stream and lake habitats.

There are also warm spring stenothermal taxa, particularly in the Hydrobiidae. However, relatively few have yet been found in the Cascades and Coast ranges, even though some occur in the nearby Great Basin drainages. Most freshwater mollusc species have narrow salinity tolerances (this does not necessarily hold on the generic or family level, particularly for such families as the Hydrobiidae), and most freshwater forms are not tolerant of acidic or very alkaline waters, although a few are specialized for alkali lakes. On average, freshwater molluscs prefer slightly alkaline habitats; as before, some Physidae, Planorbidae, or Sphaeriidae are the exceptions. As regards lithology, many species prefer calcareous substrate or waters derived from calcareous rock units, such as limestone and dolomite. Diversity is often lowest on basic igneous rocks such as granites, or in extremely oligotrophic waters originating in areas underlain by such lithologies.

Life history of freshwater molluscs varies. Most cold water snails are semelparous breeders with single-year life spans. A few taxa, such as *Valvata*, may sometimes live for two years. *Juga* may have a life span of 5-7 years and reach maturity in 3 years (Furnish, 1990). Pulmonates are often iteroparous breeders with up to several-year life spans. However, specialized pulmonates, including cold water stenotherms like the Lancidae, have 1-year life spans and are semelparous. Most Pacific Northwest Hydrobiidae (*Fluminicola, Lyogyrus, Pyrgulopsis*) are short-lived (1 year), require at least several months to reach breeding age, and are semelparous. A few spring forms may be iteroparous, or may reach maturity in less than three months. Most Sphaeriidae essentially have 1 year life spans. Many of these small clams are iteroparous, though each brood is often small. None of the Pacific Coast freshwater molluscs have free-swimming veliger larvae. Most freshwater snails lay eggs, although a few, and the sphaeriids, are brooders. Many freshwater snails are hermaphroditic, but there are major exceptions, including most Hydrobiidae and Pleuroceridae, which are generally dioecious. Unionacean bivalves are mostly dioecious, have long life spans and are semelparous, often with comparatively long annual breeding seasons. Almost all of these large bivalves have a parasitic larval stage (the glochidial stage) resident for some weeks on the gills of freshwater fishes. The bivalves are dependent on the fish for distribution and successful completion of their life cycle. Host specificity of the glochidial stage varies from species to species; some are quite species-specific. Thus, fish host distribution is as vital to their survival as is availability of proper subadult and adult habitat. Many larger freshwater clams are dioecious; sphaeriids are hermaphroditic and brood their young.

The breeding season for many of the Pacific Coast states cold-water snails appears to be between February-May, with egg laying and hatching taking place between March-July. Details and precise timing vary from species to species; but eggs are quite often laid about 1 month after copulation, and the eggs often hatch about 1 month after they are laid. Cold-water stenotherm breeding adults commonly die shortly after laying eggs. Metabolism varies seasonally and diurnally, with greater activity in the spring and summer and in the daytime. Certain species, particularly of freshwater snails, are also strongly photophobic. Seasonality, both in regard to metabolic rate and reproduction, appears to apply to river species more than to spring forms, but is still pronounced in the latter. Some snail species are quite sensitive to variations in insolation or to physical disturbance, often releasing their hold on the substrate if disturbed. Some species are relatively active; but the majority (even of the active forms) do not voluntarily travel far from their place of birth, and thus are sessile for all practical purposes. This is particularly true for forms that are predominantly or totally perilithon feeders, such as *Vorticifex*, *Lanx*, and *Fluminicola*, and even some of the eurytopic types (such as many Physidae) may not travel far in flowing water habitats.

Given the foregoing, many Pacific Coast freshwater mollusc species can be characterized overall as stenotopic (more specifically as cold water stenotherms). These species in particular can be quite vulnerable to major disturbance events, due to certain features of their life history. Annual population turnover in most freshwater mollusc species is considerable (*e.g.* 90% or more for the hydrobiid *Fluminicola columbiana* Hemphill, 1899 and the lancid *Fisherola nuttalli* (Haldeman, 1841): Coutant & Becker, 1970; unpublished data), and many breed only once, generally in a well-defined and short season. In disturbed streams, molluscs may be disproportionately affected. This often makes them particularly effective bioindicators of pollution and other forms of environmental disturbance.

Generally, increase in siltation, decrease in flow, nutrient enrichment, pollution, dredging or other channel alterations, and damming or other flow impediments are likely to extirpate the more sensitive species. Most of the endemic or geographically restricted species discussed here prefer unpolluted, swift-flowing, clear, cold, well-oxygenated water. Level bottom and gravel-boulder substrate with relatively little rooted vegetation is also preferable for most. Families such as the Hydrobiidae (especially the Hydrobiinae, Amnicolinae, Nymphophylinae, and Lithoglyphinae), Pleuroceridae, and Lancidae are essentially restricted to such habitats. In some cases the reason is clearly physiological; the Lancidae, *e.g.*, lack lungs and gills. Respiration is managed by the heavily vascularized mantle, and the heart rate is rapid compared to the related Lymnaeidae (Baker, 1925). Highly oxygenated, clean water is the *desideratum*, and the limpets have been observed to succumb quickly in warm, stagnant, or non-flowing water. Sites with mobile substrate, seasonal siltation, warm water, glacial flour, or impoundments have low diversity and few if any endemics or sensitive species. Many of the described freshwater taxa are found mostly at low to middle elevations in streams and springs; there are a few lake endemics in this region. Destruction of springs by grazing, logging, and human exploitation (troughing or capping for stock use; diversion for human [water supply, fish hatcheries] or stock use) has already caused extensive extinction of species throughout western North America. In general, few of the cold water species can live in impoundments; nor can they tolerate eutropification. As most are obligate perilithon grazers and require stable substrate, siltation (such as that resulting from clear-cutting) generally means loss of habitat and at least local extirpation. Many taxa respond negatively to increases in water temperature, such as caused by increased insolation from removal of vegetation. Many freshwater mollusc species face habitat loss or degradation from a combination of human actions operating simultaneously. Bonneville Power Administration dams on the lower Columbia River, for example, eliminated much rocky substrate and free-flowing river habitat. Siltation in the lower Columbia Basin, however, is exacerbated by lumbering and other land-clearing activities, *e.g.* on Gifford Pinchot and Mt. Hood National Forests, as well as by agriculture. A side effect of lumbering on the lower Columbia has been pollution of river habitats by fleeting and storage of logs on the river and by discharge of sawmill wastes into the river.

Now that many streams in the Pacific Coast states have been affected by human modification, molluscs and their role in the ecosystem are often overlooked. In undisturbed habitats they are often extremely abundant, and in fact frequently dominate the invertebrate fauna, both in terms of biomass and number of individuals. The genus *Juga*, for example, may comprise more than 90% of the total invertebrate biomass in some streams (Hawkins & Furnish, 1987). Similar densities are often encountered in Northwest lotic settings with the genera *Fluminicola, Vorticifex*, *Pyrgulopsis*, *Lanx*, and *Corbicula*. Sphaeriids are also often very abundant (often dominant) in soft substrate communities. Examples of all of these occurrences still can be readily found in the less disturbed rivers, particularly the Umpqua, Rogue, Klamath, and Sacramento systems. Similar densities of the large bivalves *Gonidea angulata* (Lea, 1838), *Margaritifera falcata* (Gould, 1850), and *Anodonta oregonensis* occur in such streams as the Okanogan (Washington) and Snake (Washington--Idaho), or in mountain lakes in the Washington Cascades.

Freshwater molluscs are mostly primary herbivores in freshwater aquatic ecosystems. In turn, the snails serve as food to a variety of freshwater fish, including game fish. Examples include native trout, native salmonids, Dolly vardens, whitefish, sturgeon, and some sculpins and squawfish. Snails are also commonly consumed by larger aquatic insects, particularly larval forms, leeches, and by a variety of birds, including ducks, geese, herons, and cranes. Large freshwater clams (and some snails) are avidly eaten by raccoons, muskrats, otters, and beavers. These molluscs were utilized extensively for food, tools, and ornament by Native Americans as well. Sphaeriids are consumed in vast numbers by bottom-feeding fish such as sturgeon and whitefish and by many waterfowl as well. The ubiquitousness of freshwater forms (in undisturbed habitats) has resulted in their use as food by a variety of animals. Various species inhabit both warm and cold springs, temporary (including woodland vernal) ponds, swamps, sloughs, and backwaters, as well as the more preferred cold and clean permanent-water habitats.

General background on freshwater mollusc ecology and biology (though with an eastern U.S. slant), is provided in Brown (1991: gastropods) and McMahon (1991: bivalves).

## Freshwater Mollusc Biogeography

The distribution of Pacific Coast state freshwater molluscs in many ways parallels that of land snails. Considering the obvious differences in habitat, any parallelism is striking. That observed results from the response of aquatic systems to major landscape features and tectonic events, particularly those dating from the Cenozoic. Like land snails, freshwater molluscs are conservative and relatively sessile, so that major changes, such as evolution of new families or introduction of a family to a new continent, are comparatively rare. Much of the area of North America west of the Rocky Mountains is rather new terrain, geologically speaking, being added to the continent as a result of large-scale tectonics, including vulcanism, mountain range formation, and microplate accretion during the last sixty million years. As a consequence, drainage evolution has been considerable, much more extensive than that east of the Rockies in the same period.

At present, the major drainage systems in the Pacific Coast states are those of the Columbia, the Interior Basin (Lahontan and peripheral), and two areas of Pacific Coast drainage interrupted by the Columbia River (Burch, 1989, fig. 20). During the late Cenozoic, several large-scale geologic processes have formed and rearranged these drainages. The rise of the Cascade, Coast, and Great Basin ranges considerably modified both drainage and climates. Most extensive mountain building took place in the Eocene, Oligocene, and Miocene. Vulcanism has been widespread since that period, and continues today. Some is associated with the formation and development of the major mountain ranges; but other events are connected with the Pliocene-Recent migration of a diapire or hot spot across the WA-OR border through southern ID to its present location at Yellowstone National Park. The extensive Columbia Basin and Snake River Plain basalts are related to this process. Plio-Pleistocene glaciation and the related Bonneville and Missoula Floods have also affected freshwater mollusc distribution.

There is a considerable literature regarding the relationship between drainage and geologic history, particularly for the Columbia Basin, Sacramento system, and Great Basin. The best single work as regards effects on molluscs is Taylor (1985); salient points will be summarized here. In the Miocene (approximately 20 million years ago (MYBP), much of the West was included in a few large and integrated drainages. The Columbia system was much smaller, and the Lahontan Basin was a coherent, outward-draining system. During the late Miocene and Pliocene, the rise of the Coast and Great Basin ranges disrupted the Lahontan system, converting it into many internally-draining small basins. Drainage of areas peripheral to the Great Basin was modified considerably during the late Pliocene and Pleistocene. Much territory, including Hells Canyon and the upper Snake, was added to the Columbia system at this time. The Snake had formerly been a Pacific-draining stream, with connections to the Klamath and Sacramento systems. Many of the large pluvial lakes formed earlier either contracted or went dry during the later Pliocene and during Pleistocene interglacials (such as the present). Only a few of these large lakes were incorporated into coastal systems (the Upper Klamath Basin is the best example); but Great Basin forms entered into the Klamath and Sacramento systems *via* such routes; in turn, California forms which had earlier penetrated into the Snake system were stranded. Many of the Pliocene lakes had considerable endemic faunas; only remnants of these persist today (such as some of the listed Idaho cold water species: Frest & Johannes, 1992a). In Washington, late Pleistocene glacial advance removed or relocated much of the freshwater fauna. Areas affected today have limited western faunas; but short-lived drainage connections during the the most extensive Pleistocene glaciation allowed a few Mississippi forms to reach the West Coast. In other cases, Miocene-Pleistocene tectonics and glaciation seems to have induced bicoastal speciation in genera present across the continent.

As a result, the freshwater mollusc fauna of each major drainage system is often composite. There is a strong continent- or world-wide component, as well as a generalized western North American element. Certain characteristic western genera, such as *Fluminicola* and *Juga*, have parallels with eastern forms (*e.g.*, *Elimia* and *Somatogyrus*); but their nearest relatives are likely to be extralimital (*e.g.*, the Chinese *Namrutua* and Japanese *Semisulcospira* for *Juga*; the South American *Potamolithus* for *Fluminicola*). In other cases, the differences in "recent" geologic history between western and eastern North America are reflected in different species swarms in the same genera, *e.g. Pyrgulopsis* and *Lyogyrus*. Sphaeriids mostly have continent-wide or even hemisphere-wide distributions; but a couple of species are western endemics. The western unionacean fauna is small compared to the 200+ eastern forms; none are common to the two regions. The more stable areas generally have core faunas, including some endemics; speciation has been rampant in the interior basins; and major portions of each large system have been added from other systems. Such areas have distinctive faunas, often with sister species in the drainage of origin and in the captured segment. Regions with complex geologic history and varied substrate are likely to have endemics, especially in springs and spring-influenced habitats. In general, the elements most exotic to North America and/or the most characteristic Pacific Coast forms tend to occur coastally or west of the Cascades, while Great Basin and eastern forms tend to be found east of the Cascades. Local biotic interpenetration and mixing are extensive, however.

## Areas with High Diversity or Endemism

As regards freshwater mollusc provinces (see Burch, 1989, fig. 20 for recent treatment), analogous considerations apply to those outlined for land snails (*q.v.*). The Pacific Drainage is situated similarly to the coastal land snail provinces. The Columbia Drainage is a separate unit; the

Interior Drainage province intersects the Northern Spotted Owl's range in northern California and southern Oregon. Endemic clusters are most noted in the family Hydrobiidae (*Fluminicola, Lyogyrus, Pyrgulopsis*) and in the pleurocerid genus *Juga*. The family Lancidae, restricted solely to western North America, is generally coastal in distribution and occurs mostly in a few streams in southwestern Oregon-northwestern California. Additionally, one genus and species occurs in the Columbia Basin, and a relict Endangered species is found at three sites in the Idaho middle Snake drainage. Freshwater species confined to single or a few streams or springs are not uncommon in western North America. Many small and some large taxa are restricted to particular streams in the region included in the Northern Spotted Owl's range.

Relatively few freshwater endemics are yet known from the North Pacific Drainage, which is analogous in position and extent to the Oregonian land snail Province. In the north portion (north of the Columbia River), only a few may occur, due to the effects of Wisconsinan glaciation. One example is the lake form *Valvata mergella*; we have been unable to re-collect any of the old populations. The Oregon and northern California portions of this province have yet to be systematically explored; but some species are known to be narrow endemics, such as *Juga (O.) chacei* and *Juga (O.) orickensis*. Endemic *Fluminicola* species clusters occur in the Upper Klamath Lake region, including Upper and Lower Klamath Lakes, Tule Lake, and the Sprague, Williamson, and Lost rivers; lower and middle Klamath (Oregon-California), and likely in the Rogue and Umpqua systems in Oregon; and the upper Sacramento system, including the Pit R., in California. *Lyogyrus* and Mississippian disjuncts occur in Washington on the east side of the Cascades and across the northern part of the state. Other *Lyogyrus* species clusters occur in the Upper Klamath Lake region and in the Pit system. Endemic *Juga* occur in the upper Sacramento system, California and in the Columbia Gorge in Washington and Oregon, as well as the southwestern Oregon-northwestern California coastal drainages.

Taking the freshwater Species of Special Concern (Tables 1-3) as a group, the following areas are most likely to have described and undescribed endemic species clusters and taxa which fall into this classification (Figure 3):

1) the lower Columbia River from The Dalles to its mouth, Washington-Oregon (examples are: *Vorticifex neritoides, Physella columbiana*; *Anodonta wahlametensis*, *Anodonta californiensis*, *Pyrgulopsis* n. sp., *Fisherola nuttalli*, possibly some *Fluminicola* species);

2) Columbia tributaries and springs in the Columbia Gorge, *i.e.*, from Portland, Oregon and Vancouver, Washington to Rufus, Oregon (several *Juga (J.)* and *Juga (O.)* species and subspecies, *Lyogyrus* n. sp.);

3) the Rogue and Umpqua systems, Oregon (*Lanx alta*, *Lanx subrotundata*, likely several *Fluminicola* species and *Juga* species);

4) the Upper Klamath Lake region, Oregon-California, including Lower and Upper Klamath

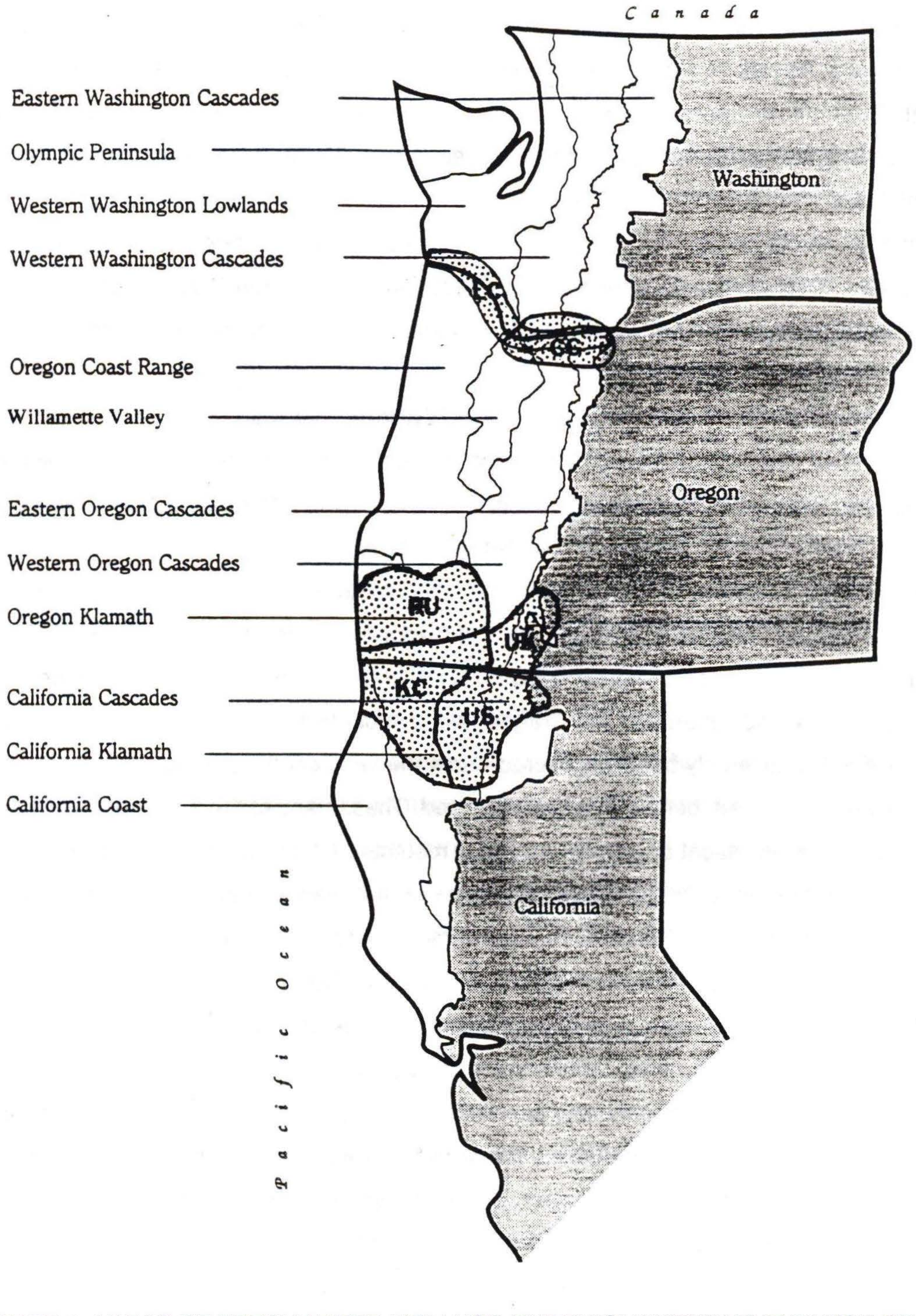
Canada
Eastern Washington Cascades
Olympic Peninsula
Western Washington Lowlands
Western Washington Cascades
Oregon Coast Range
Willamette Valley
Eastern Oregon Cascades
Western Oregon Cascades
Oregon Klamath
California Cascades
California Klamath
California Coast
LC
CG
RU
UK
KC
US
Washington
Oregon
California
Pacific Ocean

FIGURE 3. AREAS OF FRESHWATER MOLLUSC ENDEMISM WITHIN THE RANGE OF THE NORTHERN SPOTTED OWL.

| | | | |
|---|---|---|---|
| LC- | lower Columbia River | CG- | Columbia Gorge |
| RU- | Rogue and Umpqua rivers | UK- | Upper Klamath Lake system |
| KL- | lower and middle Klamath system | US- | Upper Sacramento system |

Lakes; Tule Lake; Clear Lake Reservoir; Lake of the Woods; and the Lost, Williamson, and Sprague rivers, as well as the Link River and upper Klamath River (*Lanx alta*, *Lanx klamathensis*, several *Fluminicola* species, several *Lyogyrus* species, *Vorticifex klamathensis* subspp., *Pyrgulopsis* species, *Helisoma newberryi newberryi*, *Pisidium ultramontanum*, *Anodonta californiensis*);

5) the lower and middle Klamath River and its tributaries and springs, including the Trinity and Smith rivers, California and Oregon (*Lanx alta*, numerous *Fluminicola* species, *Pisidium ultramontanum*, *Juga (O.) orickensis*, *Juga (O.) chacei*, and probably other *Juga (O.)* species; *Juga (C.) acutifilosa*);

6) the upper Sacramento system, Shasta Co., California, including the Sacramento R., Pit R,, McCloud R., Hat Creek, and their tributaries and springs (numerous *Fluminicola* species, *Lyogyrus* species, *Juga (C.) acutifilosa*, *Juga (C.) occata*, *Pyrgulopsis intermedia*, *Helisoma newberryi newberryi*, *Pisidium ultramontanum*, *Anodonta wahlametensis*, *Anodonta californiensis*).

Other endemic species clusters are located just outside of the Northern Spotted Owl's range. Examples are Clear Lake and vicinity in Lake Co., California; Eagle Lake and vicinity in Lassen Co., California; Goose Lake and vicinity in Modoc Co., California; and the lower Deschutes River in Wasco, Sherman, and Jefferson cos., Oregon. Within most freshwater mollusc groups, most truly narrow endemics have only been discovered within the last decade and many more remain to be found; if they are, indeed, before they are extirpated. Thus, many of the long-known species here discussed do not represent originally extremely restricted taxa, but ones that have become so recently due to human activities. The recent pace of discovery of new hydrobiids indicates that much remains to be elucidated about freshwater mollusc distribution in this region. Nevertheless, the main outlines have been clear for many years and are unlikely to change. It is highly probable that additional colonies of many of the species discussed herein remain to be found; but it is very unlikely that the status recommendations made in Table 2 are overly pessimistic. We have been comparatively conservative in choosing species for inclusion: many more taxa could have better claims. However, our lack of sufficient first-hand knowledge of some has resulted in their exclusion at this time. Moreover, the pace of forest cutting has so accelerated that many sites collected in 1986-88 are now not collectable. We have not had sufficient time to recheck the large number of sites that would be necessary to determine current condition of some taxa. Examples include *Valvata mergella* and *Margaritifera falcata* (cited above), and typical *Fluminicola nuttallianus* and *Fluminicola virens* [most literature citations are wrong]. Among the terrestrial forms, similar arguments can be made for many species, including *Hemphillia dromedarius*, *Prophysaon andersoni*, *Prophysaon foliolatum*, *Prophysaon fasciatum*, and *Pristiloma wascoense*. Many of the smaller terrestrial forms need detailed re-investigation (*i.e.*, *Vertigo*, *Pristiloma*) to determine their current status and distribution.

## MOLLUSCS AS BIOLOGICAL INDICATORS

In many regards, molluscs are an especially practical group for use in assessing the general health of the terrestrial and aquatic ecosystem. They are present in some numbers in almost any environment. Certain species are eurytopic; however, many species are stenotopic and unusually sensitive to various kinds of disturbance or pollution. Most species respond quickly and obviously to disturbance. As almost all are relatively sessile and complete their life cycles in place, they are particularly convenient for site-specific assessments. Sampling procedures are relatively simple and can be readily quantified. As it happens, many of the Species of Special Concern would be readily useful indicator species (*e.g.*, the species of *Monadenia*, *Vespericola*, *Prophysaon*, and *Fluminicola*). Mollusc centers of diversity generally correlate well with those determined from other groups; examples are common from plants, fish, salamanders, and insects. Similarly, mollusc abundance tends to peak in particularly high diversity locales.

The presence of a number of local endemics makes molluscs of unusual biogeographic significance. As compared to insects, there are relatively few taxa, many are comparatively large, taxonomy and morphology are comparatively comprehensible and straightforward, and most can be easily identified. About half of the total taxa in old growth forests have already been described, and relatively comprehensive identification manuals are now, or shortly will be, available for them. The shell of most is durable, making them both obvious and also quite likely to be preserved as fossils or subfossils. They are one-part animals, and most can be identified from the shell alone. The extensive fossil record of some provides a long-term background history unavailable with most groups. An extensive literature attempts to relate fossils to past and present climates, drainages, and large-scale geologic and ecological processes.

## SPECIES OF SPECIAL CONCERN

### Background

In order to compile the species records listed below, the freshwater and land mollusc fauna of Washington, Oregon, and northern California was reviewed. Starting points were Pilsbry (1939-48), Burch (1989), and references therein, including Henderson (1929, 1936). The periodical literature published subsequent to 1936-48 was also reviewed, as were available consultant's reports and other "grey " material. We have collected freshwater and land molluscs in these states since 1986; where practical, such records were incorporated also. Information from amateur collectors was also included, where their material was examined and verified by us. The original compilation (Frest & Johannes, 1991b) discussed 57 forms. This list was incorporated in the draft and final draft Spotted Owl Recovery Plan (USFWS, 1992a b) and the SAT report (Thomas *et al.*, 1993). Subsequent to the 1991 compilation, done under a very tight schedule [as was this report], we took the opportunity to re-examine, reanalyze, and augment available information. Review of and comments on the 1991 report by B. Roth, L. Deyrup-Olsen, and others were most helpful. Additional collecting in 1992-93 has also enabled us to refine the original work. More precise definition of recovery proposals and of the Northern Spotted Owl Recovery Plan's scope and intent has also modified our opinions in regard to some species. As a result, this expanded list is believed to be more accurate and comprehensive, if still conservative. As always, more time and study would have been helpful.

Tables 1-3 list a total of 108 mollusc species or subspecies, 57 freshwater and 51 land, currently known to have ranges partly or wholly within that of the Northern Spotted Owl. All are here regarded as Species of Special Concern (in the usage of USFWS, 1992a, b). All are either present or potential candidates for Federal listing; most (105) are regarded as priority species (USFWS usage, as above). These taxa represent roughly 35% of the area's total currently described mollusc diversity, and perhaps 20% of estimated actual diversity. Fifty-six occur in northern California; 54 in western Oregon; and 26 in western Washington. None of these species and subspecies are listed as federal Endangered or Threatened species at the moment (USFWS, 1992c). Eight are Federal candidates. In general, these species are not on state Threatened or Endangered lists (the exception is *Monadenia setosa*), although state Natural Heritage or Biodiversity programs track many, and some are state Species of Special Concern (USFWS, 1992a, b). Most of the taxa have been suggested for listing by malacologists previously (*e.g.* Taylor, 1970; Smith, 1970; Roth, 1972; Clarke, 1976; Taylor, 1981; Frest & Johannes, 1991b; and sendings to various federal and state agencies by us, 1988-1992).

Our lists and discussions differ from those made previously in that they: 1) are based on more recent information, including research and project collections by Deixis Consultants personnel (T. Frest, E. Johannes, J. Johannes) of many taxa from 1986-1992; 2) include some previously unknown or unconsidered species and subspecies; 3) exclude some taxa now known to be either more broadly distributed than earlier thought or taxonomically suspect; and 4) are restricted to forms known to occur within the range of the Northern Spotted Owl. We have attempted this time to include undescribed taxa and to identify known and suspected areas of endemism. The listing is conservative in that some taxa now regarded as either extinct or too poorly known for adequate range definition (*i.e.*, occur in relatively unstudied areas; are too recently discovered to be fully evaluated; or occur in poorly studied microhabitats) are deliberately excluded. Further documentation of the species and subspecies listed in Tables 1-3 is provided below in the form of short, referenced discussions of each. For reasons of space or to protect taxa of particular concern, localities are not precise. In most cases, more detailed information is available in the literature or from the authors.

Of the 108 mollusc species and subspecies listed, some are of especial concern. Important factors were: extremely restricted current distribution or local endemism; occurrence solely or largely in particularly threatened habitat, such as low-elevation old growth forest; sensitivity; or declining populations (generally, all of the above). Additionally, preference is given here to those taxa with ranges entirely encompassed by that of the Northern Spotted Owl. Within this group, species known or likely to occur on Forest Service or BLM lands were favored strongly for consideration. Similarly, species known or thought to be old growth associates or riparian associates were given special emphasis in making selections for inclusion here; many taxa qualify under both criteria (Table 2). Candidate taxa were automatically considered to be priority species.

In practice, our criteria closely mirror those used by Thomas *et al.* (1993, p. 261) for developing a "short list" from the much larger list of species that occur in old growth or late successional forests. Most or all taxa considered here would qualify under a combination of two or more of the SAT's 4 Criteria and 9 factors. As can be seen from the species discussions, nearly all taxa were included for two or more of the reasons outlined above. The 105 priority taxa that meet these conditions are indicated in Table 1. It should be emphasized, however, that, due to lack of recent collections of some taxa, this listing is particularly conservative. It is likely that all Table 1 taxa are now, or soon will be, subject to similar problems. It is also highly likely that many taxa not discussed here should be included (for examples, see preceding section). This listing should thus be considered as somewhat tentative. As time and information growth demands, we hope to revise and reissue it.

## Options

In connection with the mandate given the Forest Ecosystem Management Working Group, we, along with Dr. Barry Roth (San Francisco, California), were asked to evaluate mollusc Species of Special Concern with regard to certain proposed management options for federal forest lands. Our rankings are given in Table 3; Dr. Roth's are summarized in Roth (1993); a summary consensus version will be included in the document produced by the Working Group. The currently viable options were defined in working documents dated April 20, 1993: in summary, these are as follows:

1) Gang of Four (Johnson, Franklin, Thomas, & Gordon, 1991) Alternative 14C;
2) Gang of Four Alternative 12A;
3) Reserved and Managed Old Growth;

4) SAT (Thomas *et al.*, 1993) + Gang of Four Alternative 8A;

5) SAT;

6) Gang of Four Option 8A;

7) Existing Forest Service and BLM management plans.

Ranking Criteria for Mollusc Species with Risk to Viability

For each species of special concern, we have evaluated proposed management alternatives with respect to the probability of long-term survival of the species on federal lands under each option. The scale ranks viability prospects from highest to lowest as follows (Thomas *et al.*, 1993, p. 264):

1) high: there is a high likelihood that the population(s) of the species would stabilize in National Forests or other public lands within the range of the Northern Spotted Owl; this takes into account natural catastrophes and uncertainties in knowledge; probability of widespread or complete extirpation is low;

2) medium high: there is a moderately high likelihood (somewhat better than even) that the population(s) of the species would stabilize in National Forests or other public lands within the range of the Northern Spotted Owl; this only to a limited extent takes into account natural catastrophes and uncertainties in knowledge; probability of widespread or complete extirpation is less than 50/50;

3) medium: there is a roughly equal chance of stabilization or extirpation of population(s) of the species in National Forests or other public lands within the range of the Northern Spotted Owl; this only to a very limited extent takes into account natural catastrophes and uncertainties in knowledge; probability of widespread or complete extirpation is about 50/50;

4) medium low: there is less than an even chance of stabilization of population(s) of the species in National Forests or other public lands within the range of the Northern Spotted Owl; this does not at all take into account natural catastrophes and uncertainties in knowledge; probability of widespread or complete extirpation is greater than 50/50;

5) low: there is little chance of stabilization of population(s) of the species in National Forests or other public lands within the range of the Northern Spotted Owl; this does not at all take into account natural catastrophes and uncertainties in knowledge; probability of widespread or complete extirpation is high;

While admittedly rather subjective, such ranking scales are sufficiently illustrative as to allow clear preferences to emerge from among complex alternatives. As originally defined (Thomas *et al.*, 1993, the time frame considered was 50 years, representing "a median duration over which adverse effects on viability as well as any significant modification of old-growth forest habitats, particularly timber harvesting, would occur" (Thomas *et al.*, *op. cit.*, p. 265). We believe that such adverse effects on molluscs and other comparatively slow-migrating or slow-dispersing groups would continue for very much longer periods, perhaps hundreds of years or more. Moreover, the limited ranges of many species means that such effects could result in absolute extinction of a species, rather than extirpation or reduction on single federal land units.

### Designated Conservation Areas

Designated Conservation Areas (abbreviated DCA, DCAs) are set-asides on National Forest and BLM lands for management of the Northern Spotted Owl and other old growth-associated species. Developed from the habitat conservation area concept used in Thomas *et al.* (1990), they are defined and mapped in the Final Draft Northern Spotted Owl Recovery Plan (USFWS, 1992b). Our evaluations of mollusc species occurrence on federal lands are heavily weighted toward these areas, as most likely to have comprehensive protection. Many sites on federal lands outside the DCAs may have sufficient protection to guarantee long-term mollusc viability through other management initiatives, such as protection of core riparian watersheds. Accordingly, we have made a special effort to highlight occurrences of Species of Special Concern on DCAs and federally-owned areas outside them (Table 1).

### Land Snails

We regard a total of 44 land snails as Species of Special Concern occurring within the range of the Northern Spotted Owl (Tables 1-3). Of these , 8 occur in Washington; 11 in Oregon, and 33 in California. Thirty-seven of these species are known or thought to be found on federal lands; many of the others occur on private inholdings or areas adjacent to public lands (Table 1). About 10 taxa are very likely to have populations within DCAs. Almost all taxa are either or both old growth or riparian associates (Table 2). In general, Options 1, 4, and 5 were thought to offer a relatively high chance of maintaining viability of these species. Options 2 & 6 appeared to offer some chance of maintaining populations of these species on federal lands. Option 3 was ranked similarly for shelled land molluscs; Option 7 appeared to be unlikely to adequately maintain these forms. We recommend listing of all but a few of these species as either Threatened or Endangered on present evidence; other species require further study.

## Slugs

Our slug rankings, covering just 7 taxa designated as Species of Special Concern, are likely overly generous (see above). Nevertheless, based on present knowledge, the rankings are closely similar to those for shelled forms (Table 3). Options 1, 4, & 5 ranked high and essentially identically; 2, 3, & 6 also seemed effective, if mediocre, options; 7 was not well received. The vast majority (6 of 7) of slug species of special concern are known to occur on federal lands (Table 1); 3 occur on or near DCAs. Essentially all species are riparian associates, at least in part; all are also at least partially old growth associates (Table 2). We believe that evidence is sufficient to recommend listing of all 7 species as either Threatened or Endangered. Of the seven ranked species, 6 are found in Washington, 5 in Oregon, and 1 in California.

## Freshwater Snails

This is the largest group of mollusc Species of Special Concern, with 54 members (Table 1). Twelve species occur in Washington; 38 in Oregon; and 22 in northern California. Evaluation of major management options was similar to that for land molluscs in that Options 1, 4, & 5 were highly regarded (Table 3). The relative lack of consideration for riparian areas and spring environments embodied in Options 2 & 6 caused them to be regarded as ineffective for freshwater forms. Option 3's effectiveness was thought to vary considerably from species to species, but in general was not regarded sanguinely. Option 7 seemed unlikely to preserve many of the freshwater forms. Evidence is sufficient for over 40 species to recommend either Endangered or Threatened status (Table 2). All of these forms can be regarded as riparian associates, and heavily affected by management of terrestrial riparian zones. Association with old growth forest is less clear for many, although this category is probably underrated herein. Most mollusc species considered herein prefer cool and shaded streams.

## Freshwater Clams

This group of freshwater molluscs is low in local diversity and generally robust; only 3 species of special concern are designated, two of which are current listing candidates.The included bivalves are more widely distributed in this region than is typical for other mollusc groups, with 2 occurring in Washington, Oregon, and California: 1 occurs in Oregon and California. All three should be listed species. Evaluations of management options and viability for them directly parallel those for freshwater snails (Tables 1-3). Other bivalve species should probably be included. The western pearlshell *Margaritifera falcata*, for example, once occurred throughout the area, essentially in all rocky-bottom native trout and salmon streams. With the demise of the native salmonid stocks that serve as glochidial hosts, the distribution has become very spotty, but just how much so is not clear. Individuals may live for 60 years or more, and thus may be present long after larval recruitment has ceased completely. This species used to literally pave the bottom in favorable habitats; few such aggregations have been recorded in the last twenty years.

## DISCUSSION

### Adequacy of Current Knowledge

As noted by Taylor (1981) for California freshwater molluscs, many new species and even genera remain to be discovered and described in the region, particularly of land and freshwater snails. We are aware of a number of such for which we as yet have insufficient knowledge of distribution or ecology to be included herein. Moreover, certain historically common taxa have tended to be overlooked by malacologists, and hence lack or have few recent records. At least one such marine species on the East Coast became extinct by the 1940s, a situation which was not noted until the 1990s (Carlton *et al.*, 1991). It is quite probable, given the poor state of biological inventories on federal lands, that many undescribed regional endemics are already extinct; certainly, some previously described taxa have not been successfully re-collected for some years. The lack of careful monitoring of even long-known rare forms has been discussed by Roth (1993).

Malacological research and knowledge are not nearly as extensive as are counterparts for certain terrestrial vertebrates and plants. Even so, interest dates to the 1830s, and the main points of taxonomy and distribution are well established. We thus have considerable confidence that an effort such as this is feasible and likely to produce robust results that can aid materially in proper management of public lands. Additional investigations are required in many areas to establish complete faunas, ecological requirements, and life histories of individual species. As noted by Roth (1993, p. 3) "current mollusk faunal lists tend to **underestimate** diversity and **overestimate** the ranges of individual taxa". A recent review of biotic inventories in the National Park system (Stohlgren & Quinn, 1992) indicated that none had comprehensive inventories of invertebrates, even of major and relatively small groups such as molluscs. There are no completely adequate surveys for freshwater molluscs in this region. Also, there are almost no adequate surveys for either land or freshwater molluscs in the western National Forests or BLM Districts. Closest are research done by Roth in Trinity National Forest (see Roth (1993) for references) and a recent survey of Black Hills National Forest (Frest & Johannes, 1993c). Both surveys were for for land snails.

Most of the little inventory work on invertebrates that has taken place on federal lands has been for arthropods. It should be noted that mollusc inventories are conducted in a somewhat different manner and using rather different methods than those appropriate for terrestrial arthropods. It is common to take small numbers of molluscs in pit traps used for beetles, spiders, and salamanders; similarly, some molluscs are secured with Berlese funnels and similar equipment. However, we have found that such methods generally miss most mollusc species and individuals in a sample plot.

## Current and Proposed Management Practices

The lack of detailed knowledge about invertebrates on public lands was also a major point of Olson (1992), specifically in regard to arthropods but with implications for all groups. Other conclusions of this report are relevant to molluscs. The high proportion of species with localized ranges led Olson (*op. cit.*, p. 9) to suggest that "proposed conservation areas for the spotted owl may be inadequate as an effective approach to invertebrate conservation". Like Olson, we fear that if only those areas located in proposed DCAs are protected, then there is a "very high probability that many invertebrate extinctions will occur in areas not covered by protected lands".

Of the 108 taxa discussed in detail below, 102 are known or very likely to occur on federal lands. Far fewer, however, are associated with the proposed DCAs. Four land snail or slug species definitely do; perhaps 10 are found nearby. For the freshwater snails and clams considered together, the corresponding figures are about 21 and 21 respectively. Thus, about 25% of the mollusc Species of Special Concern are known to have at least 1 population within DCA boundaries; and an additional 30% have populations nearby. DCAs, strictly interpreted, would possibly protect only a small part of the total at best, and even expanded DCAs would on the most generous interpretation perhaps cover about 56%. For those "fortunate" taxa, only in a few cases is it clear that sufficient populations to ensure long-term viability are present on or near DCAs. While it is quite possible that thorough inventories of the DCAs would increase the number of Species of Special Concern and/or number of populations found therein significantly, it is also very likely that careful searches in other areas would be equally or more productive, and that such searches could increase the number of excluded taxa as much or more.

The DCAs cannot be expected to fully represent federal lands' mollusc biodiversity. They are not randomly placed, and were originally intended to maintain a single vertebrate species. Most are at high or medium elevations. Lowland forests and larger permanent streams and springs are not well represented. Certain habitats especially favored by molluscs, such as level riparian areas, larger springs, and taluses may also not be sufficiently covered. Another consideration is that mollusc diversity is not even crudely evenly distributed within the Northern Spotted Owl's range but is strongly concentrated in areally limited centers of endemism (Figures 2, 3). To maintain the long-term viability of the majority of mollusc Species of Special Concern, preservation efforts should be focussed on the identified and likely centers of endemism. Contemplated additions to the DCAs, especially the riparian corridors and core watersheds, should be helpful. However, these seemingly either connect (Owl-oriented) DCAs or were designed to secure occurrences of specific fish stocks. They thus suffer from the same drawbacks as the DCAs.

Under current management practices standard to the Forest Service and BLM, "consideration provided to wildlife is below that provided to consumptive uses such as livestock grazing, logging, and mining" (GAO, 1991, p. 18). For example, the General Mining Law of 1872 gives mining primacy over other uses of federal lands. Such consumptive uses, at least as now practiced, are often directly inimical to species preservation. The cited GAO report also noted the low levels of funding and staffing provided for wildlife programs. It concluded that, in cases of conflict, consumptive uses were often favored despite acknowledged negative impacts on wildlife. Moreover, most planned wildlife actions were demonstrably not actually being implemented by the managing agencies. Even on paper, such actions almost always are directed at species perceived as "glamorous" or as favored by the public -particularly the Three Fs (furred, feathered, or finned)- often at the expense of other taxa. The general lack of even roughly complete species inventories of federal lands has been commented upon above. Recent proposals to conduct such inventories are a step in the right direction: but this step will require considerable time and resources to implement, and should not be pursued precipitously. Major changes in policy and management will be necessary to supplant and repair past actions. In the last few years, most of the Pacific Coast states National Forests and BLM Districts have completed Land and Resource Management Plans or their equivalents. So far, none of those we have seen have adequately addressed biodiversity concerns. Most, for example, go little beyond Three F species; none adequately address invertebrates; and most fail to even mention them.

## SPECIES DISCUSSIONS

Species-level taxonomy used here largely follows Pilsbry (1939-48) for land snails, except where superseded by more recent works, especially those of Roth and his collaborators in California and Oregon (mostly referenced by species below: see also Roth, 1993). Higher taxonomy also is often that of Pilsbry (*op. cit.*), with later modifications: see Vaught, 1989 for summary. For freshwater molluscs, we follow Burch (1989) in preference to Vaught (1989). In a few cases, we follow Taylor (especially 1981) in preference to Burch (1989). Hydrobiid taxonomy is that of Hershler and others (see references). Common names for species are those recognized by Turgeon *et al.* (1988) wherever possible. Roth (see references) has added later names for land snails. Our coinages are for new taxa, missed species, subspecies, or taxa described subsequent to publication of Turgeon *et al.* (1988) and not named by others.

Land Snails

***Ancotrema voyanum* (Newcomb, 1865)** hooded lancetooth

**Type locality**: Canyon Creek, Trinity Co., CA.

**Ecology**: Low to middle elevations; old growth and riparian associate; habitat includes leaf litter along streams, under logs, among brush, and in talus (Roth, 1993).

**Original distribution**: Portions of the Trinity Mts. (Klamath Province), Trinity and Shasta cos., CA.

**Current distribution**: Eleven sites in the Trinity R. drainage (Trinity Co., CA) and one site in Shasta Co., CA (Pilsbry, 1946; Roth, 1993). Some sites are in Shasta and Trinity National Forests.

**Criteria for inclusion:** Old growth associate, riparian associate. Occurrence on public lands. Partly within DCAs CD-46 and CD-51 (Roth, 1993).

**Recommended status**: Currently has none. Should be Endangered in CA and Federally.

**References**: Pilsbry (1946); Smith (1970); Roth (1991, 1993).

***Cryptomastix devia* (Gould, 1846)** Puget oregonian

**Type locality**: Puget Sound (no specific site)

**Ecology**: Low to middle elevations; old growth and riparian associate; habitat includes leaf litter along streams, under logs, seeps and springy areas.

**Original distribution**: Scattered sites from southern Vancouver Island, B.C. to the west end of the Columbia Gorge, including the following counties: King, Clark, Skamania, and Thurston (WA), Multnomah (OR).

**Current distribution**: Known to survive at a few scattered sites in King and Thurston cos., WA. The species is likely to survive on Ft. Lewis (no recent collections), DCA WD-45, and near Carson, WA (near DCA WD-1). The record from Lake Chelan State Park, Chelan Co., WA (Branson, 1980) needs confirmation.

**Criteria for inclusion:** Old growth associate, riparian associate. Probable occurrence on public lands, including DCAs.

**Recommended status**: Currently has none. Should be Endangered in WA, OR, and Federally.

**References**: Pilsbry (1940); Branson (1980); Deixis Consultants, 1987-92.

***Cryptomastix hendersoni* (Pilsbry, 1928)** Columbia oregonian

**Type locality**: The Dalles, Wasco Co., OR.

**Ecology**: Low to middle elevations; riparian associate; generally near seeps and springs, sometimes in leaf litter along streams, under logs, among brush, and in basalt talus.

**Original distribution**: Portions of the central and eastern Columbia Gorge, Hood River, Wasco, & Sherman cos., OR, and Skamania & Klickitat cos., WA. Records from Yakima Co., WA are possible, but we have found other species only so far. Records for Umatilla Co., OR, Walla Walla Co., WA, and Adams Co., ID are another taxon.

**Current distribution**: Still survives at a few sites in Klickitat Co., WA and Wasco & Sherman cos., OR. Most sites are in the Columbia River Gorge National Scenic Area.

**Criteria for inclusion:** Riparian associate; probable occurrence on public lands.

**Recommended status:** Currently has none. Should be Endangered in WA, OR, and Federally.

**References**: Pilsbry (1940); Deixis Consultants, 1988-92.

***Helminthoglypta (Helminthoglypta) arrosa monticola* Roth, 1982** we suggest mountain shoulderband

**Type locality:** 1.6 mi. SE of King Peak, King Range, Humboldt Co., CA (Roth, 1982).

**Ecology:** Talus slope shaded by Douglas fir, tan oak, and madrone, over 900 m elevation (Roth, 1982).

**Original distribution:** King Range, Humboldt Co., CA.

**Current distribution:** Known from 2 sites in the King Range National Conservation Area (BLM) (Roth, 1982).

**Criteria for inclusion:** Old growth associate. Occurrence on public lands. Unusual habitat for a member of the *arrosa* complex. Range within DCA CD-8 (Roth, 1993).

**Recommended status:** Should be considered Endangered by CA and by the federal government.

**References:** Roth (1982, 1993).

***Helminthoglypta (Helminthoglypta) hertleini* Hanna & Smith, 1937** Oregon shoulderband

**Type locality**: Basalt talus 6.6 mi. east of junction of Klamath Falls Rd. with U.S. hwy. 99, Jackson Co., OR.

**Ecology**: Found in basalt rockslides (taluses), sometimes with brush cover; partial riparian association (Roth, 1993).

**Original distribution**: Siskyou Mts., Rogue R. drainage, Jackson Co., OR, and Shasta R. canyon, Siskiyou Co., CA (Roth, 1993).

**Current distribution**: Three sites, one in Jackson and two in Siskiyou cos. The Jackson Co. site is on or near BLM land (Medford District). The Shasta River sites are also on or adjacent to BLM land, and near the east border of Klamath National Forest.

**Criteria for inclusion:** Riparian associate in part (Roth, 1993). Probable occurrence on public lands.

**Recommended status**: Has none presently. Should be State (CA, OR) and Federal Endangered.

**References**: Pilsbry (1939); Roth (1972, 1993).

***Helminthoglypta (Helminthoglypta) intercessa* Roth, 1987** we suggest intermediate shoulderband

**Type locality:** Mendocino Co., CA, bluffs immediately north of mouth of Pudding Creek, elevation 7 m (Roth, 1987).

**Ecology:** "Habitat includes coastal dunes and coastal scrub with mixture of exotic weeds, but also includes redwood forest along a river. " (Roth, 1993, p. 10).

**Original distribution:** Coastal areas in Mendocino and Humboldt cos., CA.

**Current distribution:** Three definite sites from two disjunct areas, one north of Ft. Bragg and the other on the south fork of the Eel River (Roth, 1987, 1993).

**Criteria for inclusion:** Narrow geographic range and coastal occurrence; probable occurrence on federal lands; old growth associate, in part; riparian associate, in part.

**Recommended status:** Probably should be considered Endangered in CA and Federally.

**References:** Roth (1987, 1993).

***Helminthoglypta (Helminthoglyptus) talmadgei* Roth, 1988** we propose Klamath shoulderband

**Type locality:** Limestone rockslide on north side of CA Hwy. 299, SE of Del Loma, Trinity Co., CA (Roth, 1988).

**Ecology:** Limestone rockslides, litter in coniferous forests, old mine tailings, and along shaded streams (Roth, 1993).

**Original distribution:** West side of Salmon Mts., Trinity and Klamath drainages, Trinity and Humboldt cos., CA: reported from a total of about 19 localities (Roth, 1988).

**Current distribution:** Mostly in Trinity and Six Rivers National Forests and Hoopa [Hupa] Valley Indian Reservation, between Junction City and Burnt Ranch, down to the junction of the Trinity and Klamath rivers.

**Criteria for inclusion:** Occurrence on public lands; old growth associate; riparian associate, in part; range partly within DCAs OD-35, CD-46, and CD-51 (Roth, 1993).

**Recommended status:** Should probably be listed as Threatened in CA and Federally.

**References:** Roth (1988, 1993).

***Megomphix californicus* Smith, 1960** California megomphix

**Type locality:** Natural Bridge Cave, Trinity National Forest, Trinity Co., CA (Smith, 1960b).

**Ecology:** In rich moist leaf litter in forest and associated with perennial seeps and springs in forested areas. "In and under moist rotting logs on streambanks" (Roth, 1993, p. 13).

**Original distribution:** Known mostly from several sites in the Trinity Alps, Trinity Co.; specimens also from the upper Sacramento R. canyon in Shasta Co., CA. We have recently seen specimens from one site near the Pit R. in Shasta Co., CA which may be this species.

**Current distribution:** Uncertain; some of the Trinity sites are recent. Known localities are in Shasta and in Trinity National Forests; possible sites also in areas administered by Lassen National Forest.

**Criteria for inclusion:** Occurrence on public lands; old growth and riparian associate.

**Recommended status:** None at present. Should be considered Threatened Federally and by the State of CA.

**References:** Smith (1960b); Roth (*pers comm.*, 1993); Deixis Consultants, 1992.

***Megomphix hemphilli* (Binney, 1879)** Oregon megomphix

**Type locality**: Olympia, Thurston Co., WA (no specific site).

**Ecology**: Generally in moist, low-middle elevation, relatively undisturbed forest.

**Original distribution**: Northern OR-northern WA, on west side of Cascades.

**Current distribution**: Found by Branson (1980) at 3 sites in Mt. Baker National Forest and 12 sites in the Olympic Peninsula (Branson, 1977), including sites in and peripheral to Olympic National Park and Olympic National Forest; rare at all. We have found it increasingly rare over the last decade, and now absent from many of Branson's sites.

**Criteria for inclusion:** Old growth associate; riparian associate; occurrence on public lands.

**Recommended status**: None at present. Should be Federally and WA and OR Threatened.

**References**: Pilsbry (1946); Branson (1977, 1980); Deixis Consultants, 1986-92.

***Monadenia (Monadenia) callipeplus* Berry, 1940** no common name

**Type locality**: One mi. above mouth of Tompkins Creek, Siskiyou Co., CA. Elev. 2300' (Berry, 1940).

**Ecology**: "[A]mid live oak" (Roth, 1972); "among rocks and leaf litter along forested streambanks" (Roth, 1993, p. 14).

**Original distribution**: Known only from 2 areas in Siskiyou Co., Scott River drainage, Marble Mts., Klamath National Forest, CA (Roth, 1972, 1993).

**Current distribution**: Two areas, as above.

**Criteria for inclusion:** Old growth associate; riparian associate; localized endemic (Roth, 1993); occurrence on public lands.

**Recommended status**: None at present. Should be Federal and State (CA) Endangered.

**References**: Berry (1940); Roth (1972, 1993); Roth & Pressley (1986).

***Monadenia (Monadenia) cristulata*** **Berry, 1940** we suggest short-crested sideband

**Type locality**: Above Pleasant Valley Lakes, Siskiyou Co., CA , elev. *ca.* 5800' (Berry, 1940).

**Ecology**: Uncertain.

**Original distribution**: Known only from 2 sites in Marble Mt. Wilderness, Klamath National Forest, Siskiyou Co., CA (Roth, 1972).

**Current distribution**: Not collected recently: see original distribution and Roth (1993).

**Criteria for inclusion:** Likely old growth and riparian associate; localized endemic; occurs on public lands; type locality in or very close to DCA CD-33 (Roth, 1993).

**Recommended status**: Currently has none: should be Federally and State (CA) Endangered on present evidence.

**References**: Berry (1940); Roth (1972, 1993).

***Monadenia (Monadenia) fidelis celeuthia*** **Berry, 1937** travelling sideband

**Type locality**: Trail, Rogue R. valley, Jackson Co., OR.

**Ecology**: Relatively low elevations in comparatively undamaged forested terrain.

**Original distribution**: Three sites in the Rogue R. valley (Pilsbry, 1939; Roth, 1993). At least one site is in Rogue River National Forest.

**Current distribution**: Uncertain; has not been recollected recently.

**Criteria for inclusion:** Likely old growth and riparian associate; occurrence on public lands. The type locality is near, but not within, DCA OD-19 (Roth, 1993). Sites on Medford District BLM lands are probable.

**Recommended status**: Has none at present. Should be considered as Federally and State (OR) Endangered.

**References**: Berry (1937); Pilsbry (1939); Roth (1993).

***Monadenia (Monadenia) fidelis flava*** **(Hemphill, 1892)** green sideband

**Type locality**: Port Orford, Curry Co., OR (*flava*). Near the mouth of the Pistol R., Curry Co., OR (*beryllica*: Chace & Chace, 1935).

**Ecology**: Generally in deciduous trees (including alder woods) and brush in wet, relatively undisturbed forest, at low elevations; also in low coastal scrub (Roth, 1981, 1993). Habits include seasonal climbing of trees in riparian corridors and shelter in deep forest floor litter (Roth, 1993, p. 18).

**Original distribution**: About 12 sites in Curry Co., OR, including some in Siskiyou National Forest and along the Rogue National Wild and Scenic River corridor. Some old sites are in DCA OD-30; and others may be in OD-29.

**Current distribution**: Uncertain: some old sites have been destroyed, but the status of most is uncertain. Collected live in Curry Co. at one site in 1988 (S. Welty, *pers. comm.*, 1990).

**Criteria for inclusion:** Riparian associate, at least in part (see Roth, 1993, p. 18 for discussion); occurrence on public lands.

**Recommended status**: None at present. Given the narrow distribution, should be Federally and State (OR) Endangered. Synonyms are *M. fidelis beryllica* Chace & Chace,1935 and *M. fidelis baxteriana* Talmadge, 1954; see Coan & Roth (1987) for status of the name *flava*: see also Roth (1993).

**References**: Chace & Chace (1935); Pilsbry (1939); Roth (1981, 1993); Coan & Roth (1987).

***Monadenia (Monadenia) fidelis klamathica* Berry, 1937** no common name at present

**Type locality**: Along Oak Flat Creek, near the Klamath R., Siskiyou Co., CA.

**Ecology**: Under logs near the Klamath R., at low elevations.

**Original distribution**: Two sites in Siskiyou Co., CA, in the main Klamath River canyon and possibly also in the Salmon River drainage (Talmadge, 1954).

**Current distribution**: Only one site known currently, five miles upstream from the forks of the Salmon R., Siskiyou Co., CA. (Walton, 1970). See comments in Roth (1993, p. 19) also. The type locality is in Klamath National Forest, on the flanks of the Marble Mts.

**Criteria for inclusion:** Range is near but not within DCA CD-33 (Roth, 1993); old growth and riparian associate; occurrence on public lands.

**Recommended status**: Currently has none; should be listed as Endangered (Federally, State (CA)) on present evidence.

**References**: Berry (1937); Pilsbry (1939); Walton (1970); Roth (1972, 1993).

***Monadenia (Monadenia) fidelis leonina* Berry, 1937** tawny sideband

**Type locality**: Beaver Creek, about 1 mi. above mouth, Siskiyou Co., CA (Pilsbry, 1939).

**Ecology**: Dead alder leaves and trunks near a stream, in relatively undisturbed forest; "among leaves (deep maple and alder leaf litter) and under debris on ground" (Roth, 1993, p. 19).

**Original distribution**: Type locality and one additional site (Pilsbry, 1939; Roth, 1993); Siskiyou Mts., Klamath National Forest.

**Current distribution**: Uncertain. It has apparently not been collected alive since the 1930's.

**Criteria for inclusion:** Old growth and riparian associate; local endemic; directly across Klamath River from DCA CD-32; occurrence on public lands.

**Recommended status**: None at present. Should be considered Endangered by both CA and the federal government.

**References**: Pilsbry (1939); Roth (1972, 1993).

***Monadenia* (*Monadenia*) *fidelis minor* (Binney, 1885)** Dalles sideband

**Type locality**: The Dalles, Wasco Co., OR.

**Ecology**: Generally in basalt talus, often north-facing, often associated with seeps and springs.

**Original distribution**: Likely central and part of the eastern Columbia Gorge; possibly south as far as 50 mi. up the Deschutes R. valley, OR. The Deschutes specimens far upriver from the mouth are most likely another related undescribed species. Klamath Lake specimens mentioned in Pilsbry (1939) are another species, as suggested by Roth (1981) and confirmed by us in 1991-92.

**Current distribution**: Survives in a few colonies in the vicinity of The Dalles and in the lower Deschutes R. valley [note: the mouth only, upriver colonies are likely another taxon]. Dead shells seen on the WA side, but no live specimens as yet. Most known sites are in the Columbia River Gorge National Scenic Area. The species has been observed to occur at some sites with the candidate Larch Mountain salamander *Plethodon larselli*, and should be managed with this in mind.

**Recommended status**: Currently a Federal (Category 2) candidate; should be listed as Endangered Federally and in OR (and possibly in WA as well).

**Criteria for inclusion:** Current federal candidate species; local endemic; occurrence on public lands.

**References**: Pilsbry (1939); Roth (1981); USFWS (1991); Deixis Consultants, 1988-1992.

***Monadenia* (*Monadenia*) *fidelis ochromphalus* Berry, 1937** yellow-base sideband

**Type locality**: Etna Creek, about two miles above Etna, Siskiyou Co., CA (Berry, 1937).

**Ecology:** "..[O]n leaves and sticks, on concrete walls of irrigation ditch and on mossy boulders and stones.." (Shapovalov *in* Pilsbry, 1939).

**Original distribution**: Three definite sites (Pilsbry, 1939; Roth, 1993), in drainage of Etna Creek (tributary to Scott R.), Marble Mts. One or more sites are in Klamath National Forest.

**Current distribution**: Needs additional work. See Roth (1993, p. 20) for further comments.

**Criteria for inclusion:** Old growth and riparian associate; local endemic; probable occurrence on public lands.

**Recommended status**: Has none currently. On present information it should be listed (both Federally and State (CA)) as Endangered.

**References**: Berry (1937); Pilsbry (1939); Talmadge (1954); Roth (1993).

***Monadenia* (*Monadenia*) *fidelis pronotis* Berry, 1931** rocky coast sideband

**Type locality**: Point St. George, Del Norte Co., CA.

**Ecology**: In rocky, moist habitats with *Mesembryanthemum* and other shoreline plants (Chace, 1951). See Roth (1993, p. 21) for discussion.

**Original distribution**: Single coastal site in Del Norte Co., CA.

**Current distribution**: Uncertain; has not been recollected recently (Roth, 1993, p. 21).

**Criteria for inclusion:** Local endemic; restricted coastal scrub habitat; current candidate; site near Redwood National Park (DCA CD-2) and west border of Six Rivers National Forest.

**Recommended status:** Currently a Federal (Category 2) candidate; should be listed as Endangered Federally and in CA.

**References**: Chace (1951); Roth (1972, 1993); USFWS (1991).

***Monadenia (Monadenia) fidelis salmonensis* Talmadge, 1954** we suggest Salmon River sideband

**Type locality**: Wooley Creek, Siskiyou Co., CA.

**Ecology**: Elev. 1200-1300' at type locality.

**Original distribution**: Glacial basins and creeks on north side of Salmon R., Marble Mts., Siskiyou Co., CA. Reported from 4 sites (Talmadge, 1954; Roth, 1993), including some in Klamath National Forest.

**Current distribution**: Uncertain; has not been recollected recently.

**Criteria for inclusion:** May be local endemic; occurrence on public lands; old growth and riparian associate; range partly within DCA CD-33 (Roth, 1993, p. 21).

**Recommended status**: Currently has none. On available evidence, it should be Federal and State (CA) Endangered.

**References**: Talmadge (1954); Roth (1972, 1993).

***Monadenia (Monadenia) rotifer* Berry, 1940** we suggest wheel sideband

**Type locality**: One-half mi. west of Whiskey Camp, Salmon Mts., Siskiyou Co., CA.

**Ecology**: Elev. about 6,000'; presumably forest.

**Original distribution**: Known only from a single site, which has not been relocated. The Salmon River, a Klamath tributary, drains the north flank of the Marble Mts. and much of the Salmon Mts., both in Klamath National Forest.

**Current distribution**: Uncertain: needs recollection, but obviously limited.

**Criteria for inclusion:** Local endemic; distinctive morphology; likely occurrence only on public land; "[o]ld growth and probable riparian associate" (Roth, 1993, p. 22).

**Recommended status**: Has none currently; should be listed as Federal and State (CA) Endangered.

**References**: Berry (1940); Roth (1972, 1993).

***Monadenia (Monadenia) scottiana* Berry, 1940** we suggest Scott River sideband

**Type locality**: Kelsey Creek 1-2 mi. above mouth (Berry, 1940), Siskiyou Co., CA.

**Ecology**: Collected on the ground on sticks and in dry leaves (Berry, 1940); in and around rockpiles in forest (Roth, 1993, p. 23).

**Original distribution**: Five nearby sites in the Scott R. drainage, Marble Mts., Klamath National Forest, Siskiyou Co., CA.

**Current distribution**: See above.

**Recommended status**: From limited past distribution, should be considered Endangered (Federal, CA); no status at present.

**Criteria for inclusion:** Old growth and riparian associate; local endemic (Roth, 1993); occurrence on public lands.

**References**: Berry (1940); Roth (1972, 1993); Roth & Pressley (1986).

***Monadenia (Monadenia) setosa* Talmadge, 1952** Trinity bristlesnail

**Type locality**: Swede Creek, tributary to Trinity R., Ironside Mt., Trinity Co., CA.

**Ecology**: On moss and forest duff on more stable portions of rock talus (Talmadge, 1952). Found mainly in Douglas fir/Yellow pine forest along streams with dense deciduous understory; less often on forested hillsides, under logs, at tree bases, on trunks, under bark of standing dead wood, and in rockpiles (Roth & Eng, 1980; Roth & Pressley, 1986; Roth, 1993, p. 24).

**Original distribution**: Nine sites in Trinity Co., CA, along Trinity R. and tributaries, with most sites in Trinity National Forest.

**Current distribution**: Same as above: see Roth & Pressley (1986) and Roth (1993) for details. This is among the best-studied western U.S. land snails.

**Criteria for inclusion:** Current federal candidate; old growth and riparian associate; localized endemic; occurrence on public lands.

**Recommended status**: This unusual snail should be considered Endangered Federally and in CA. Currently a Federal Category 2 candidate (USFWS ,1991).

**References**: Talmadge (1952); Roth (1972, 1993); Roth & Pressley (1986); USFWS (1991).

***Monadenia (Shastelix) chaceana* (Berry, 1940)** we suggest Chace sideband

**Type locality**: Among rocks about halfway up a spur of Badger Mountain on west side of Shasta River canyon, not far from its mouth, in Siskiyou Co., CA.

**Ecology**: Old sites apparently were in lower reaches of major drainages, in limestone rockslides; also "along rivers" (Roth, 1993, p. 14).

**Original distribution**: "...[O]nly known from the general vicinity of the type locality, in the Hornbrook Quadrangle...and from one site (Loc. 6) in the Yreka Quadrangle..." (Roth, 1981a, p. 398); a total of 6 sites in the Shasta and Little Shasta drainages (Roth, 1993).

**Current distribution**: See above; some old sites are known to survive (Roth & Pressley, 1986). Some sites are on BLM lands.

**Criteria for inclusion:** Local endemic; occurrence on public lands.

**Recommended status**: The species should be considered Endangered both by CA and by the federal government. Currently, it has no special status.

**References**: Pilsbry (1939); Roth (1981a, 1993); Roth & Pressley (1986).

***Monadenia (Shastelix) churchi* Hanna & Smith, 1933** Klamath sideband

**Type locality**: Lava rock-slide 2.1 miles east of Payne's Creek Station, Tehama Co., CA.

**Ecology**: Chiefly lives in rock slides (talus), but sometimes also occurs under forest debris in heavy shade (wooded hillsides) (Pilsbry, 1939; Roth & Pressley, 1986; Roth, 1993). This species is not restricted to limestone substrates but has been found also in lava [*sic*: presumably basalt] rockslides. Many sites around Shasta Lake are in brush and pine-oak woodland (Roth, 1981a, 1993).

**Original distribution**: Fairly wide distribution in north-central CA historically, particularly in Shasta Co.; Roth (1993, p. 15) lists a total of 37 sites in Siskyou, Trinity, Shasta, Tehama, and Butte cos., CA.

**Current distribution**: Checks of some old sites in 1991 indicated that some historic colonies are extinct. Some sites are in Shasta National Forest, Trinity National Forest, Whiskeytown-Shasta-Trinity National Recreation Area, or in areas administered by Lassen National Forest.

**Criteria for inclusion:** Old growth associate in part; riparian associate in part; occurrence on public lands. Note that Roth (1993, p. 15) indicates that Trinity River drainage populations may be a distinct species.

**Recommended status**: Currently has none. Should be Federal and State (CA) Threatened.

**References**: Pilsbry (1939); Roth (1981, 1993); Deixis Consultants, 1991.

***Monadenia (Shastelix) troglodytes troglodytes* Hanna & Smith, 1933** Shasta sideband

**Type locality**: Samwel Cave, Shasta Co., CA.

**Ecology**: Restricted to areas with discontinuous limestone blocks (Roth, 1981) [calcareous soil and rock outcrops, karst terrain]; habitat is often brush-covered talus in regions of brush and pine-oak woodland (Roth, 1993, p. 24).

**Original distribution**: Until 1963 this subspecies was only known as Pleistocene fossils from Samwel Cave and Potter Creek Cave, near Shasta Lake. It was first found live in the immediate area of Samwel Cave (Walton, 1970). Known sites are in Shasta Co., CA.

**Current distribution**: This species is now known to occur at about 8 sites, mostly along the McCloud R. arm of Shasta Lake, ranging in altitude from 330 to 760 m, and one locality on limestone near the Pit R. arm of Shasta Lake (Roth, 1981, 1993). Most of the old sites were collected in the 1970's or earlier, and their present status is unknown. Some sites are known to survive, including localities in Shasta National Forest and Whiskeytown-Shasta-Trinity National Recreation Area.

**Criteria for inclusion:** Current federal candidate; occurrence on public lands; local endemic.

**Recommended status**: Should be State (CA) and Federal Endangered; the species is currently a Federal Category 2 candidate (USFWS, 1991).

**References**: Pilsbry (1939); Walton (1970); Roth (1981a, 1993); USFWS (1991).

***Monadenia (Shastelix) troglodytes wintu*** **Roth, 1981** we suggest Wintu sideband

**Type locality**: Cave between two limestone buttes at south end of Gray Rocks, above Pit R. arm of Shasta Lake, Shasta Co., CA (Roth, 1981).

**Ecology**: This species is found associated with limestone and has similar habitat requirements to those noted above for *M. troglodytes troglodytes:* Roth (1993, p. 25) noted occurrence in brush and pine-oak woodland, often in brush-covered talus.

**Original distribution**: Several sites associated with limestone on the Pit R. arm, and one site on the south shore of Shasta Lake, Shasta Co., CA (Roth 1981).

**Current distribution**: Most of these sites were last collected in the 1970's or earlier, and their present status is unknown. Some sites certainly survive. Among these are sites in Shasta National Forest and Whiskeytown-Shasta-Trinity National Recreation Area.

**Criteria for inclusion:** Local endemic; occurrence on public lands; current federal candidate.

**Recommended status**: None at present. The subspecies should be State (CA) and Federal Endangered; the nominate subspecies is a Federal candidate.

**References**: Roth (1981, 1993).

***Oreohelix*** **n. sp. 1** we suggest Chelan mountainsnail

**Type locality**: None designated as yet; undescribed species.

**Ecology**: This species is found associated with schist talus in Douglas fir forest at a moderate elevation.

**Original distribution**: A single site Wenatchee National Forest, east of the border of DCA WD-31. This same species was likely referred to by Smith (1937, p. 77) as follows: "Farther up the river, on the steep slope bordering the south side of Lake Chelan, a totally different race was collected." We were unable to locate these specimens in the CAS collections.

**Current distribution**: One site, as above. This appears to be a moderate elevation species, rather different in habitat than the lowland talus-dwelling *O. strigosa strigosa* and *O. junii* of this part of the Columbia Valley. The nearest relative is another undescribed species from Yakima Canyon.

**Criteria for inclusion:** Local endemic; occurrence on public lands; old growth associate.

**Recommended status**: At present, has none. The species should be State (WA) and Federal Endangered.

**References**: Deixis Consultants, 1992.

***Pristiloma arcticum crateris* Pilsbry, 1946** we suggest Crater Lake tightcoil

**Type locality**: One mile south of Crater Lake, Klamath Co., OR.

**Ecology**: Uncertain. Related species found at high elevations live along small streams, in leaf litter in forest, near the edges of seeps or bogs, and under cushion plants in open mountain meadows.

**Original distribution**: A single site in Crater Lake National Park, Klamath Co., OR.

**Current distribution**: Uncertain; has not been recollected recently. Occurrence in adjoining portions of Umpqua and Winema National Forests, including DCA OD-20, is possible.

**Criteria for inclusion:** Local endemic; occurrence on public lands.

**Recommended status**: None at present. The subspecies should be State (OR) and Federal Endangered.

**References**: Henderson (1935); Pilsbry (1946).

***Pristiloma pilsbryi* Vanatta, 1899** crowned tightcoil

**Type locality**: Portland (no specific site), Multnomah Co., OR.

**Ecology**: "This species is most abundant under the dense thickets of salal [*Gaultheria shallon*] near the coast; it usually occupies the deeper, more rotten strata of decaying leaves" (Baker, 1931).

**Original distribution**: Multnomah Co., OR and Pacific Co., WA.

**Current distribution**: Uncertain; has not been recollected recently: Branson (1977, 1980) also did not find sites in the WA Cascades or Olympics. There is still some chance of survival for this form in Pacific and Wahkiakum cos., WA and Clatsop and Columbia cos., OR.

**Criteria for inclusion:** Local endemic; riparian associate; old growth associate. No old growth survives in SW WA.

**Recommended status**: None at present. The species should be State (WA, OR) and Federal Endangered.

**References**: Baker (1931); Pilsbry (1946).

***Punctum (Toltecia) hannai* Roth, 1985** we suggest Hanna spot

**Type locality:** North of Trinity Alps Camp, Sturay Fork, Trinity River, Trinity Co., CA, elevation 3000'.

**Ecology:** Species of *Punctum* are most frequent in moist leaf litter in forests and, in more open areas, along streams or near seeps, springs, bogs, and swamps.

**Original distribution:** Three sites, 1 in the Trinity Alps, Trinity Co.; and 2 in the Sierra Nevadas, Tuolumne and Mariposa cos., CA.

**Current distribution:** See above and Roth (1985b, 1993). At least one site is in Trinity National Forest; another is in Yosemite National Forest.

**Criteria for inclusion:** Localized species; riparian associate; old growth associate; occurs on public lands.

**Recommended status:** Threatened, both in CA and federally; though it appears highly localized, it could be more widespread than now thought.

**References:** Roth (1985b, 1993).

***Trilobopsis roperi* (Pilsbry,1889)** Shasta chaparral

**Type locality**: Redding, in drift of the Sacramento River, Shasta Co., CA.

**Ecology**: "...[W]ell drained limestone talus slopes over which there is some protective shade" (Hanna, *pers. comm.*, quoted in Pilsbry, 1940, p. 787); lightly to deeply shaded limestone rockslides with cover of shrubs or oak (Roth, 1993).

**Original distribution**: Redding and 6 miles east of Ingot, Shasta County, in a slide of limestone detritus on the north side of road between Redding and Alturas; other sites on and south of the Pit R. between Redding and Montgomery Creek.

**Current distribution**: About 5 sites in Shasta Co, CA, as above (Roth, 1993). Some sites are likely in Shasta National Forest and Whiskeytown-Shasta-Trinity National Recreation Area. Roth (1993) suggests potential for co-occurrence with the Shasta salamander *Hydromantes shastae*; both species should be managed with this in mind.

**Criteria for inclusion:** Local endemic; occurrence on public lands.

**Recommended status**: Currently has none; should be State (CA) and Federal Endangered.

**References**: Pilsbry (1940); Roth (1972, 1993).

***Trilobopsis tehamana* (Pilsbry, 1928)** Tehama chaparral

**Type locality**: Battle Creek, Tehama Co.; Shasta R. canyon, Siskiyou Co., CA.

**Ecology**: "...Found usually in shaded rockpiles.....rockpiles along the bank of the river" (Smith, 1960a, p. 97); "typical habitat includes rockslides and....leaf litter and under debris on ground" (Roth, 1993, p. 23).

**Original distribution**: Two sites in Siskiyou Co., 1 in Tehama Co., 1 in Shasta Co., 1 in Butte Co.,CA; Smith, 1960a; Roth, 1993). The Pollard Creek site is believed to be on Shasta National forest lands; the Shasta River canyon sites are on BLM land.

**Current distribution**: Uncertain. Some of the old sites have not been recollected for decades. Likely to be very local in occurrence. Roth (1993) suggests review of the Siskiyou Co. populations to confirm their identity with the Tehama, Shasta, and Butte Co. populations.

**Criteria for inclusion:** Local endemic; occurrence on public lands; old growth and riparian associate (Roth, 1993, p. 28).

**Recommended status**: Has none at present. Should be State (CA) and Federal Endangered.

**References**: Pilsbry (1940); Smith (1960); Roth (1972, 1993).

***Vertigo*** **n. sp. 1** we suggest Hoko vertigo

**Type locality:** Undescribed species: to be designated at the time of formal description.

**Ecology:** At base of wooded slope near stream; moderate elevation.

**Original distribution:** Single site, along Hoko R. valley, Clallam Co., WA.

**Current distribution:** See above; undescribed taxon. The locality is in the Olympic Mts., not far from Olympic National Forest (DCA WD-49), and it is likely that populations occur there also.

**Criteria for inclusion:** Old growth and riparian associate; local endemic.

**Recommended status:** Probably should be considered Endangered both by WA and federally.

**References:** S. Welty (*pers comm.*, 1992); Deixis Consultants, 1993.

***Vespericola depressa*** **(Pilsbry & Henderson, 1936)** Dalles hesperian

**Type locality**: The Dalles, Wasco Co., OR.

**Ecology**: Found in lowland forests and in basalt taluses, with and without cover.

**Original distribution**: Columbia Gorge from about Vancouver, WA to Rufus, OR; Clark, Skamania, and Klickitat Cos., WA and Hood River, Wasco, and Sherman cos., OR.

**Current distribution**: Survives at very scattered localities in the original range, which includes sites in Hood River National Forest and Columbia River Gorge National Scenic Area (possibly, sites in Gifford Pinchot National Forest as well). Can occur with the candidate Larch Mountain salamander *Plethodon larselli*, and should be managed with this in mind.

**Recommended status**: Has none at present, but should be Endangered Federally and in WA and OR. A distinct taxon at the species level or higher.

**References**: Pilsbry (1940); Deixis Consultants, 1987-92.

***Vespericola eritrichius*** **(Berry, 1939)** no common name

**Type locality:** Foot of bluff on ocean side of peninsula at Table Bluff, Humboldt Co., CA.

**Ecology:** Among moisture-loving vegetation in forests; shelters under logs and bark on ground (Berry, 1939; Roth, 1993).

**Original distribution:** Several sites in western Humboldt and Mendocino cos., CA.

**Current distribution:** Roth (1993) specifies 5 sites as above, including one in Frank and Bess Smith Redwoods State Park.

**Criteria for inclusion:** Old growth associate; riparian associate; limited distribution; occurrence on state lands. [Note: we did not rank this species in Table 3 because it may not occur on federal lands: if it does, its rankings would be identical to those for *Vespericola euthales* (*q.v.*); "may yet be found on federal land" (Roth, 1993, p. 30).]

**Recommended status:** On present evidence, should be regarded as Endangered in CA and federally. Has no status currently.

**References:** Berry (1939); Roth (1993).

***Vespericola euthales* (Berry, 1939)** large hesperian

**Type locality:** Chaffey Ranch, 7 mi. above mouth of Klamath R., Del Norte Co., CA.

**Ecology:** Lives in moist redwood forest and along streamsides; shelters under logs and bark on ground (Roth, 1993).

**Original distribution:** Western Del Norte, Humboldt, and Mendocino cos., CA.

**Current distribution:** Roth (1993) reports this species from about 18 sites in the counties mentioned above, including sites in Jedediah Smith Redwoods State Park, Prairie Creek Redwoods State Park, and Humboldt Redwoods State Park.

**Criteria for inclusion:** Old growth and riparian associate; occurs on state lands.

**Recommended status:** Should probably be listed as Threatened in CA and federally.

**References:** Berry (1939); Pilsbry (1940); Roth (1993).

***Vespericola karakorum* Talmadge, 1962** Karok hesperian

**Type locality**: Sawmill Gulch, north side of Klamath R., Humboldt Co., CA.

**Ecology**: Edges of stream beds, always close to water, in deep, narrow gorges; possibly nocturnal (Talmadge, 1962; Roth, 1972); habits includes sheltering under logs and bark on ground (Roth, 1993).

**Original distribution**: Three nearby sites near the Klamath R. in Humboldt Co., CA.

**Current distribution**: Confirmed from three sites (Roth, 1992, 1993); reported from others by Hunt & DeMartini (1979), but this work needs rechecking. At least 1 site is in Six Rivers National Forest.

**Criteria for inclusion:** Old growth and riparian associate; local endemic, "a distinct species with a restricted range" (Roth, 1993, p. 27); occurrence on public lands.

**Recommended status**: Currently a Federal Category 2 candidate: should be listed as Endangered Federally and by CA.

**References**: Talmadge (1962); Roth (1972, 1992, 1993); USFWS (1991).

***Vespericola marinensis* Roth & Miller, 1993** Marin hesperian

**Type locality:** Bear Valley Trail, Point Reyes, Marin Co., CA (Roth & Miller, 1993).

**Ecology:** "The habitat includes moist spots in coastal brushfields and chaparral vegetation; under leaves of cow-parsnip (*Heracleum lanatum*); around spring seeps; in leafmold along streams; in alder woods; and in mixed evergreen forest." (Roth & Miller, *op. cit.*, p. 142).

**Original distribution:** Western Marin Co., from about 26 localities (Roth & Miller, 1993; Roth, 1993).

**Current distribution:** See above; newly discriminated taxon.

**Criteria for inclusion:** Old growth and riparian associate; major part of range within DCA CD-28 and Point Reyes National Seashore.

**Recommended status:** Probably should be considered Threatened both by CA and federally. Has no status at present.

**References:** Roth & Miller (1993); Roth (1993).

***Vespericola* n. sp. 1** [Sasquatch hesperian]

**Type locality:** Siskiyou Co., CA, along small stream tributary to Salmon R., 4.3 km east of Etna-Somes Bar Road/CA Hwy. 96.

**Ecology:** Under logs, particularly along a stream.

**Original distribution:** Single site, as above.

**Current distribution:** See above; undescribed taxon. Marble Mts., Klamath National Forest.

**Criteria for inclusion:** Old growth and riparian associate; local endemic; occurs on public lands.

**Recommended status:** Probably should be considered Endangered both by CA and federally.

**References:** Roth (1993, p. 36) for specifics above; new species to be described by Roth & Miller.

***Vespericola* n. sp. 2** [Reeves Bar hesperian]

**Type locality:** Tributary ravine to Reeves Canyon, N. of Willits, Mendocino Co., CA.

**Ecology:** Habitat under logs along streams.

**Original distribution:** Two or three sites in Humboldt and Mendocino cos., CA.

**Current distribution:** See above; undescribed taxon.

**Criteria for inclusion:** Old growth and riparian associate; local endemic; occurs on state lands.

**Recommended status:** Probably should be considered Endangered both by CA and federally.

**References:** Roth (1993, p. 36-37) provides the specifics listed above; new species to be described by Roth & Miller.

***Vespericola* n. sp. 3** [Klamath hesperian]

**Type locality:** Aiken Creek, NE of Weitchpec, Humboldt Co., CA.

**Ecology:** No information.

**Original distribution:** A few localities in Humboldt Co., CA, in the Klamath River drainage, Hoopa [Hupa] Valley Indian Reservation, and Six Rivers National Forest.

**Current distribution:** See above; newly discriminated taxon.

**Criteria for inclusion:** Old growth and riparian associate; local endemic; occurs on public lands.

**Recommended status:** Probably should be considered Endangered both by CA and federally.

**References:** Roth (1993, p. 37), which is the source for specifics mentioned above; to be described by Roth & Miller.

***Vespericola pressleyi*** **Roth, 1985** Pressley hesperian

**Type locality:** S. side of Trinity River 0.4 km east of mouth of Price Creek, Trinity Co., CA (Roth, 1993).

**Ecology:** Stream bank perennial spring seep and dense stand of maple and alder; under *Rubrus* (Roth, 1985a, 1993).

**Original distribution:** Limited area in Trinity Mts., Trinity Co., CA (Trinity National Forest).

**Current distribution:** Reported from 4 sites (Roth, 1993).

**Criteria for inclusion:** Old growth associate; riparian associate in part; occurrence on public lands.

**Recommended status:** Probably should be considered Endangered by the state of CA and federally. Has no special status at present.

**References:** Roth (1985a, 1993).

***Vespericola shasta*** **(Berry, 1921)** Shasta hesperian

**Type locality**: La Moine, Shasta Co., CA.

**Ecology**: Always-moist lowland environments, such as streamsides, springs and seeps, marshes, and mouths of caves (*pers obs.*; Roth, 1993).

**Original distribution**: La Moine and roadside spring 24 miles east of Placerville along the Lincoln Highway, El Dorado Co., CA [this second locality is somewhat doubtful].

**Current distribution**: Scattered sites in Trinity Co. and Shasta Co. (Roth, 1993; *pers obs.*), some in Shasta and Trinity National Forests. Sites in areas administered by Lassen National Forest are probable also. This species may be composite. The type locality is near the border of DCA CD-49. Other sites may be in DCA CD-82.

**Criteria for inclusion:** Old growth and riparian associate; occurrence on public lands; likely a local endemic.

**Recommended status**: None currently. Should be State (CA) and Federal Endangered.

**References**: Pilsbry (1940); Roth (1972, 1993); Deixis Consultants, 1991-92.

***Vespericola sierranus* (Berry, 1921)** Siskiyou hesperian

**Type locality**: Two miles north of Weed, Siskiyou Co., CA.

**Ecology**: Spring seeps, deep leaf litter along stream banks, and under debris on ground (Roth, 1993).

**Original distribution**: Broadly scattered sites in the following counties: OR, Jackson; CA, Siskiyou, Plumas, Nevada, Placer, El Dorado (Roth, 1993).

**Current distribution**: Cited by Roth (1993) from about 17 localities. Among other areas, there are sites in Shasta National Forest. Other localities apparently with this species are in Rogue River National Forest and on BLM lands (Medford District).

**Criteria for inclusion:** Old growth and riparian associate; occurrence on public lands.

**Recommended status**: Currently has none. Should be State (CA, OR) and Federal Threatened.

**References**: Pilsbry (1940); Roth (1972, 1993); Deixis Consultants, 1991-92.

Slugs

***Deroceras hesperium* Pilsbry, 1944** evening fieldslug

**Type locality**: Oswego, Clackamas Co., OR.

**Ecology**: Reported by Branson (1977) from mixed salmonberry, hemlock, spruce, and black cottonwood forest; elev. 8 m.

**Original distribution**: Lower Columbia R. (OR side) west of the Cascades crest to southern British Columbia (Vancouver Island). Specific old sites were in Clackamas and Multnomah cos., OR and Clallam Co., WA.

**Current distribution**: Found more or less recently by Branson (1977) at 2 sites on the Olympic Peninsula, WA, but not at any of his Cascades sites (Branson,1980). One site is in Olympic National Park.

**Criteria for inclusion:** Old growth and riparian associate; habitat loss; occurrence on public lands. The Olympic National Park site is in DCA WD-47.

**Recommended status**: Has none at present. Should be listed as Endangered Federally and State (WA, OR).

**Remarks**: Pilsbry (1948); Branson (1977); Deixis Consultants, 1987-91.

***Hemphillia burringtoni* (Pilsbry, 1948)** Burrington jumping-slug

**Type locality**: Rialto Beach, just north of the mouth of the Quillayute R., Clallam Co., WA.

**Ecology**: Probably similar to other West Coast species; elevation approximately 3-4,000'. Some sites are in dense, undisturbed rain forest.

**Original distribution**: Known from only 9 sites, including ones in Olympic National Park and Bush Pacific State Park, Olympic Peninsula, WA. Old sites are in Clallam, Jefferson, and Mason cos., WA.

**Current distribution**: Branson (1977) reports it from 8 sites. We have not found this species at our WA sites, 1986-1991. Recent localities include ones in Olympic National Forest and Olympic National Park.

**Criteria for inclusion:** Old growth and riparian associate; occurrence on public lands; local endemic; some sites are in or near DCA WD-47; the type locality is in DCA WD-51.

**Recommended status**: Has none at present. Should be considered Threatened Federally and by WA.

**References**: Pilsbry (1948); Branson (1972, 1977); Deixis Consultants, 1986-1991.

***Hemphillia glandulosa* (Binney & Binney, 1872)** warty jumping-slug

**Type locality**: Astoria, Clatsop Co., OR.

**Ecology**: Relatively moist and undisturbed coniferous forest, generally at low to middle elevations.

**Original distribution**: From the Columbia R. (OR side) to British Columbia, west of the Cascades crest. Old sites were in Multnomah and Clatsop cos., OR; and Clallam, Greys Harbor, Thurston, Pierce, King, and Lewis cos., WA.

**Current distribution**: Uncertain. Branson (1972, 1977, 1980) did not find this species. Many of the old sites were in the Willapa Hills and are probably extirpated, as this area has been almost completely lumbered. Most other localities were from areas now strongly urbanized. We have not seen this species at our sites. Some old sites were in Olympic National Park and Olympic National Forest.

**Criteria for inclusion:** Old growth and riparian association, at least in part; probable occurrence on public lands; habitat loss.

**Recommended status**: Has none at present. Probably should be listed as Threatened Federally and in WA; and as Endangered in OR.

**References**: Pilsbry (1948); Branson (1972, 1977, 1980).

***Hemphillia malonei* Pilsbry, 1917** Malone jumping-slug

**Type locality**: Tawney's Hotel, Salmon R., 12 mi. from Mt. Hood, Clackamas Co., OR.

**Ecology**: Generally in open but uncut forest, at low to high elevations (type locality at 1,600'; others at 3,900').

**Original distribution**: Western and central Columbia Gorge in Hood River Co., Clackamas Co., and Multnomah Co., OR; could also extend into WA (particularly Clark and Skamania cos.).

**Current distribution**: Known to survive at Larch Mt., Multnomah Co., OR (Kozloff & Vance, 1958; recollected in 1990). Sites are in Mt. Hood National Forest and the Columbia River Gorge National Scenic Area, in or near DCA OD-1 and OD-2. This species may co-occur with the Larch Mountain salamander *Plethodon larselli.*

**Criteria for inclusion:** Old growth and riparian association; local endemic; occurrence on public lands, including DCAs.

**Recommended status**: Has none at present. Should be considered Endangered Federally and in OR.

**References**: Pilsbry (1948); Kozloff & Vance (1958); Deixis Consultants, 1989-90.

***Hemphillia pantherina* Branson, 1975** panther jumping-slug

**Type locality**: Miller Creek crossing, Gifford Pinchot National Forest, Skamania Co., WA.

**Ecology**: Beneath deep forest litter.

**Original distribution**: Reported only from the type locality.

**Current distribution**: Not collected since the original report. The only known site is near the west boundary of DCA WD-3.

**Criteria for inclusion:** Old growth and riparian associate; local endemic; occurrence on public lands.

**Recommended status**: Should be considered Endangered Federally and in WA; obviously much more rare than *H. dromedarius*, reported from 16 sites in WA by Branson (1972, 1977, 1980). Branson (1980) did many more sites in Gifford Pinchot National Forest without finding additional colonies of this species.

**References**: Branson (1975). We examined the holotype in 1991; it is clearly a distinct species.

***Prophysaon coeruleum* Cockerell, 1890** blue-grey tail-dropper

**Type locality**: Olympia, Thurston Co., WA.

**Ecology**: Probably similar to other WA slugs with restricted distributions; *i.e.*, relatively undisturbed, moist coniferous forest, from low to middle elevations.

**Original distribution**: Willamette R. Valley, OR to Olympia, WA; Benton, Clackamas, and Multnomah cos., OR; Thurston and King cos., WA.

**Current distribution**: Not found recently by us or by Branson (1977, 1980); most of the previously recorded sites are now in urban areas.

**Criteria for inclusion:** Old growth and riparian associate; massive habitat loss.

**Recommended status**: Has none at present. Should probably be considered Endangered Federally and in both WA and OR.

**References**: Pilsbry (1948); Deixis Consultants, 1988-91.

***Prophysaon dubium* Cockerell, 1890** papillose tail-dropper

**Type locality**: Olympia, Thurston Co., WA.

**Ecology**: See last species. "Habitat includes a rockslide with light brush cover and the edge of a mountain meadow within a few feet of a stream." (Roth, 1993, p. 26).

**Original distribution**: Four sites in northern OR and southwestern WA: Pierce and Thurston cos., WA; Hood River Co., OR; Trinity Co., CA; one site in Trinity National Forest.

**Current distribution**: Has not been collected recently, either by us or by Branson (1977, 1980), in WA and OR; collected in CA (Roth and Pressley, 1983).

**Criteria for inclusion:** Old growth and riparian associate; occurrence on public lands.

**Recommended status**: Has none currently. On available evidence should be listed Endangered Federally and WA, OR, and CA.

**References**: Pilsbry (1948); Roth (1993); Deixis Consultants, 1991-92.

## Freshwater Snails

***Fisherola nuttalli nuttalli* (Haldeman, 1841)** shortface lanx

**Type locality**: "Lower Columbia River" near the old mouth of the Willamette River near Portland, Multnomah Co., OR (could have been from the Willamette R. itself also).

**Ecology:** Generally found in unpolluted swift-flowing, highly oxygenated water on boulder-gravel substrate, often in the vicinity of rapids, in small to large rivers. This species sometimes occurs with *Fluminicola columbiana*.

**Original distribution**: Formerly widespread in the lower Columbia R., Snake R., and a few major tributaries, WA-OR-ID.

**Current distribution**: The lower Columbia R. populations are largely extinct due to habitat modification caused by Bonneville Power Administration [BPA] dams and impoundments, although one occurrence is known near Bonneville Dam (from NMFS collections, 1990): still survives in the Hanford Reach, WA; the lower Deschutes R. and the John Day R., OR; part of the Snake R. (middle Snake, ID; Hells Canyon, OR-ID); the Salmon R., ID, and the Methow and Okanogan rivers, WA; see Neitzel & Frest (1989, 1992, 1993), Frest (in prep.), and Frest & Johannes, 1991a for details. Many of these areas are on (or influenced by management practices on) federal lands, *e.g.* Hanford Site (DOE), Deschutes Wild and Scenic River, Hells Canyon National Recreation Area; Okanogan National Forest; Gifford Pinchot National Forest; Mt. Hood National Forest; and Bonneville Power Administration.

**Criteria for inclusion:** Riparian associate; current federal candidate; occurs on public lands.

**Recommended status**: Recommended as Federally Threatened; Threatened in WA; Threatened in OR; and Endangered in ID by Frest (in prep.). Currently a Category 3 Federal candidate.

**References**: Taylor (1982a); Neitzel & Frest (1989, 1992, 1993); USFWS (1991); Frest (in prep.); Frest & Johannes, 1991a.

***Fluminicola columbiana* Hemphill, in Pilsbry, 1899** Columbia pebblesnail

**Type locality**: Columbia R. at Wallula, Walla Walla Co., WA.

**Ecology**: Restricted to small-large rivers, in swift current on gravel to boulder substrate in cold, unpolluted, highly oxygenated water. Sometimes co-occurs with *Fisherola nuttalli*.

**Original distribution**: Lower Columbia R. and a few of its major tributaries in WA, OR, and ID.

**Current distribution**: Possibly extinct in the lower Columbia R., WA-OR, and definitely extinct in most of the middle and upper Columbia R., WA, MT, and British Columbia; and in the Payette R., ID; still survives in the Okanogan and Methow rivers, WA; the Hanford Reach, WA; and a limited portion of the Snake R. and possibly a few of its tributaries (Frest, in prep.). Many of the remaining sites are on, or influenced by management practices on, federal lands, *e.g.* Hanford Site (DOE), Hells Canyon National Recreation Area; Okanogan National Forest; Gifford Pinchot National Forest; Mt. Hood National Forest; and Bonneville Power Administration. Lower Columbia R. rocky and free-flowing lotic habitat largely has been eliminated by BPA dams and impoundments; siltation in this area has also been affected by agricultural practices and by clear-cutting on adjacent National Forests.

**Criteria for inclusion:** Current federal candidate; occurrence on public lands; riparian associate.

**Recommended status**: Currently a Federal Category 2 candidate. Should be considered Endangered Federally and in WA, OR, and ID (Frest, in prep.).

**References**: Taylor (1982b); Neitzel & Frest (1989, 1992, 1993); USFWS (1991); Frest (in prep.).

***Fluminicola* n. sp. 1** Klamath pebblesnail

**Type locality**: None, as the species has yet to be described.

**Ecology**: This species occurs in Upper Klamath Lake and part of the Klamath River, generally in areas with gravel-boulder substrate and some flow. This species, like most *Fluminicola*, prefers cold oligotrophic water with high DO. It is found only rarely in springs and avoids areas with dense macrophyte beds. It sometimes occurs with other endemic *Fluminicola* spp., *Lanx alta*, and *Lanx klamathensis*, *Lyogyrus* spp., *Helisoma newberryi*, or *Pisidium ultramontanum*.

**Original distribution**: Klamath R., Siskiyou Co., CA, and Klamath Co., OR.

**Current distribution**: Middle and upper Klamath R., but now very sporadic (absent from impoundments and polluted stretches), Siskiyou Co., CA; Upper Klamath Lake and major spring-fed tributaries, Klamath Co., OR, including sites in Winema and Rogue River National Forests and Upper Klamath Lake National Wildlife Refuge. Among other areas, sites are on DCA OD-58. Other localities are on Medford District BLM lands included in an LS/OG-1.

**Criteria for inclusion:** Local endemic; occurrence on public lands; occurrence in DCA; riparian associate.

**Recommended status**: At present has none; should be considered Endangered in OR and CA, as well as federally.

**References**: Deixis Consultants, 1991-92.

***Fluminicola* n. sp. 2** tall pebblesnail

**Type locality**: None designated; undescribed species.

**Ecology**: Confined to a large undisturbed cold spring draining into Upper Klamath Lake, Klamath Co., OR. The species occurs on pebbles and cobbles and is a perilithon grazer. Few macrophytes are present.

**Original distribution**: Likely restricted to larger springs tributary to Upper Klamath Lake and related drainages, CA-OR (especially Klamath Co., OR)

**Current distribution**: Known from a single site on private land adjacent to Winema National Forest. Other sites are likely on nearby Upper Klamath Lake National Wildlife Refuge and Winema National Forest lands, including DCA OD-58.

**Criteria for inclusion:** Local endemic; likely occurrence on public lands; proximity to DCA; riparian associate.

**Recommended status**: Has none at present. This species should be federally listed as Endangered; it should be listed similarly in OR.

**References**: Deixis Consultants, 1991-92.

***Fluminicola* n. sp. 3** Klamath Rim pebblesnail

**Type locality**: None has been designated yet for this recently discovered species.

**Ecology**: Small cold spring in very shallow water; gravel-cobble substrate; no macrophytes present. The snail occurs only in shaded areas and may be photophobic.

**Original distribution**: Uncertain; likely restricted to the middle portion of the Klamath drainage, *i.e.* below Upper Klamath Lake and above Copco Reservoir; Klamath Co., OR and Siskiyou Co., CA.

**Current distribution**: Single site in Klamath Co., OR, on Medford District BLM lands. The area is currently badly grazed; adjacent springs do not have this species. Site is on lands included in LS/OG-1 category.

**Criteria for inclusion:** Local endemic; occurrence on public lands; riparian associate.

**Recommended status**: Should be considered Endangered in OR and federally. Has no status currently.

**References**: Deixis Consultants, 1991.

***Fluminicola* n. sp. 4** nerite pebblesnail

**Type locality**: Will not be designated until the formal description is published.

**Ecology**: Large cold springs and their outflows, with exceptional water quality, gravel-boulder substrate. Rarely associated with macrophytes; perilithon and periphyton grazer. This species is associated with other endemic *Fluminicola* spp. and with *Juga acutifilosa*.

**Original distribution**: So far, known only from one spring complex; absent from immediately adjoining drainages. This species, like other SW OR-NW CA *Fluminicola*, is a narrow endemic, likely confined to part of a single river system (middle Klamath River).

**Current distribution**: Three spring sites in single creek tributary to Klamath River, Jackson Co., OR. Sites are on private, Weyerhauser, and Medford District BLM lands; some are part of a municipal water supply (Yreka, CA), have been modified, and are lightly grazed. Associated with potentially Endangered endemic fish stocks, *e.g.* the Jenny Creek sucker. This area lies within a few miles of DCA OD-22, and occurrence on it is probable.

**Criteria for inclusion:** Local endemic; occurrence on public lands; riparian associate.

**Recommended status**: Should be listed as Endangered in OR and federally.

**References**: Deixis Consultants, 1991-92.

***Fluminicola* n. sp. 5** toothed pebblesnail

**Type locality**: To be designated when the formal description is published.

**Ecology**: Very large cold springs and their outflows; exceptional water quality, gravel-boulder substrate. Rarely associated with macrophytes; perilithon and periphyton grazer.

**Original distribution**: As yet known only from about 3 sites in a single creek drainage; not found in immediately adjoining drainages. Probably always a narrow endemic, likely limited to tributaries of the middle Klamath River, OR-CA. This species is associated with other endemic *Fluminicola* spp. and with *Juga acutifilosa*.

**Current distribution**: Three sites in a single large spring complex in a creek tributary to Klamath River, Jackson Co., OR. Sites are on private, Weyerhauser, and Medford District BLM lands; some source areas are part of a municipal water supply and have been modified (Yreka, CA); part of the area is sometimes grazed also. Associated with potentially Endangered endemic fish stocks. The sites are within a few miles of the east boundary of DCA OD-22.

**Criteria for inclusion:** Local endemic; occurrence on public lands; riparian associate.

**Recommended status**: Should be listed as Endangered in OR and federally.

**References**: Deixis Consultants, 1991-92.

***Fluminicola* n. sp. 6** diminutive pebblesnail

**Type locality**: To be designated in formal publication of the species.

**Ecology**: Exceptionally large cold springs and their outflows; rarely associated with macrophytes; perilithon and periphyton grazer. Found in areas with excellent water quality, gravel-boulder substrate; very cold and clear flowing water. This species is associated with other endemic *Fluminicola* spp. and with *Juga acutifilosa*.

**Original distribution**: Found only in a single large spring complex, at about 3 separate sites; absent from immediately adjoining drainages and their tributary springs. Another local endemic, likely confined to portions of the middle Klamath River drainage.

**Current distribution**: Single large spring complex in creek tributary to Klamath River, Jackson Co., OR; sites are on private, Weyerhauser, and Medford District BLM lands. The source areas have been modified and are part of a municipal water supply (Yreka, CA); part of the area of occurrence is grazed. Associated with potentially Endangered endemic fish stocks. Localities are a few miles from the east border of DCA OD-22, and occurrence within this area is probable.

**Criteria for inclusion:** Local endemic; occurrence on public lands; riparian associate.

**Recommended status**: Should be listed as Endangered in OR and federally. Has no special status at present.

**References**: Deixis Consultants, 1991-92.

***Fluminicola* n. sp. 7** topaz pebblesnail

**Type locality**: Will be designated when the species is formally described.

**Ecology**: Confined to a single large spring-influenced creek; the species occurs mostly on undersides of larger liths in swift flows. Water quality is exceptional; high DO, clear, very cold. Associates include other endemic *Fluminicola* spp. and *Juga acutifilosa*.

**Original distribution**: Uncertain; likely always a narrow endemic confined to tributaries of the middle Klamath River in OR and CA.

**Current distribution**: Known only from a single large spring run in Jackson Co., OR, tributary to the middle Klamath River. The known sites are on private, Weyerhauser, and Medford District BLM lands. The source areas for the spring run have been modified and are part of the Yreka, CA water supply. They are in part grazed from time to time. Associated with potentially Endangered endemic fish stocks, such as the Jenny Creek sucker and Jenny Creek redband. The site is located a few miles east of the east border of DCA OD-22.

**Criteria for inclusion:** Local endemic; occurrence on public lands; riparian associate.

**Recommended status**: This very rare taxon should be listed as Endangered, both in OR and federally.

**References**: Deixis Consultants, 1991-92.

***Fluminicola* n. sp. 8** Fall Creek pebblesnail

**Type locality**: None designated, pending formal description of the species.

**Ecology**: Occurs in large cold exceptionally pristine springs and their outflows, including medium-sized creeks. Common on gravel-cobble substrate, but also associated with dense *Rorippa* stands in relatively shallow water. This species is associated with other endemic *Fluminicola* spp. and with *Juga acutifilosa*.

**Original distribution**: Likely confined to a few large spring complexes and spring-influenced creeks in the middle Klamath drainage in Jackson Co., OR, and parts of Siskiyou Co., CA.

**Current distribution**: The known sites are on private, Weyerhauser, and Medford District BLM lands. One creek has been impounded for a PG & E hydropower development. The source area for another spring run has been modified and is part of the Yreka, CA water supply. Much of the area has been grazed to varying extents, and the species is less common or absent in such areas. Associated with potentially Endangered endemic fish stocks, such as the Jenny Creek sucker and Jenny Creek redband. The known localities are located a few miles east of the east border of DCA OD-22. Occurrence on OD-22 is probable.

**Criteria for inclusion:** Local endemic; occurrence on public lands; riparian associate.

**Recommended status**: Should be listed federally and in OR as Endangered.

**References**: Deixis Consultants, 1991-92.

***Fluminicola* n. sp. 9** lunate pebblesnail

**Type locality**: None as yet; to be designated when the species is named and formally described.

**Ecology**: Found in a large spring-influenced creek. The species occurs on sides and undersides of cobbles and boulders in rather swift flow. This taxon may be photophobic; it appears to graze on perilithon, including red algae. Associated molluscs include *Juga acutifilosa* and other endemic *Fluminicola* spp.

**Original distribution**: Uncertain; likely always a narrow endemic confined to large spring-fed tributaries of the middle Klamath R. in OR and CA.

**Current distribution**: Known only from a single large spring run that is a tributary to the middle Klamath R., Jackson Co., OR. The known sites are on private lands; other colonies may occur on immediately adjacent Medford District BLM and Weyerhauser property. The source areas for the spring run have been modified and are part of the Yreka, CA water supply; this species is absent from grazed portions of the spring complex. Associated with potentially Endangered endemic fish stocks, such as the Jenny Creek sucker and Jenny Creek redband. The occurrence is a few miles from the east boundary of DCA OD-22.

**Criteria for inclusion:** Local endemic; occurrence on public lands; riparian associate.

**Recommended status:** This very rare taxon has no status currently, but should be listed as Endangered, both in OR and federally.

**References**: Deixis Consultants, 1991-92.

***Fluminicola* n. sp. 10** Keene Creek pebblesnail

**Type locality**: Will be designated as part of the formal species description.

**Ecology**: Found in small to medium-sized springs and spring-influenced creeks.

**Original distribution**: Probably restricted to portions of the middle Klamath drainage in Jackson Co., OR and part of Siskiyou Co., CA.

**Current distribution**: Seems restricted to portions of the Jenny Creek drainage; some sites are on Medford District BLM lands, including areas within DCA OD-22.

**Criteria for inclusion:** Local endemic; occurrence on public lands, including a DCA; riparian associate.

**Recommended status**: Has no status at present. Probably should be listed as Endangered (both by the state of OR and federally). Much of the Jenny Creek system has been modified for a municipal water system (Yreka, CA); there are major reservoirs on Keene Creek and Jenny Creek, and a major flume system eliminated or modified many springs along the Jenny Creek corridor. Most of the smaller springs have been grazed out, and there is extensive grazing impact along some portions of the larger creeks.

**References**: Deixis Consultants, 1991-92.

***Fluminicola* n. sp. 11** Fredenburg pebblesnail

**Type locality**: None as yet; the species has not been described.

**Ecology**: Occurs in a narrow and shallow small cold spring run, on cobbles and gravel. Associated with *Mimulus* and *Rorippa*.

**Original distribution**: Uncertain; likely a narrow endemic confined largely to a few spring runs tributary to the middle Klamath drainage, Jackson Co., OR.

**Current distribution**: Found at a single site; several other springs in the immediate area have been completely trampled out by grazing cattle. Appears to be in DCA OD-22, on lands included in Medford District BLM holdings.

**Criteria for inclusion:** Local endemic; occurrence on public lands, including a DCA; riparian associate.

**Recommended status**: Presently has no status. Should be listed as OR and federally Endangered; the only known site was heavily impacted in 1992 by cattle and at an earlier date by road building. Adjacent small springs are grazed out and lack molluscs. The whole surrounding area has been impacted heavily by grazing.

**References**: Deixis Consultants, 1991-92.

***Fluminicola* n. sp. 12** Umpqua pebblesnail

**Type locality**: To be designated when the formal description is published.

**Ecology**: Relatively pristine river headwaters and spring-influenced areas, on stable solid (gravel-boulder) substrate. Not associated with macrophytes.

**Original distribution**: Uncertain; appears endemic to headwaters of the Umpqua R., Douglas Co., OR.

**Current distribution**: North Fork of the Umpqua R., Umpqua National Forest, Douglas Co., OR. At least one site is in DCA OD-19.

**Criteria for inclusion:** Local endemic; occurrence on public lands, including a DCA; riparian associate.

**Recommended status**: Uncertain; probably should be listed, but more field work on the Umpqua system should be done.

**References**: Aquatic Biology Associates, 1992; Deixis Consultants, 1993.

***Fluminicola* n. sp. 13** Sacramento pebblesnail

**Type locality**: Will be designated as part of the formal description process.

**Ecology**: Found in the headwaters of the upper Sacramento R., on cobbles and boulders in moderate-swift currents, generally near shore. A perilithon grazer.

**Original distribution**: Apparently an upper Sacramento R. endemic.

**Current distribution**: Found now only in a few sites along the upper Sacramento R., Shasta Co., CA. Sites surviving the Cantara spill of 1991 are mostly on private lands; previously, the species likely ranged onto Shasta National Forest lands, and will again if recovery of the river is successful. Management of nearby DCAs CD-64, 65, 66, 67, & 68 will likely impact this species.

**Criteria for inclusion:** Local endemic; former occurrence on public lands; riparian associate.

**Recommended status**: Should be listed as an Endangered species by the State of CA and federally as well. Has no special status at present.

**References**: Deixis Consultants, 1992.

***Fluminicola* n. sp. 14** Potem pebblesnail

**Type locality**: None at present, pending formal description.

**Ecology**: Occurs on muddy-silty substrate in small cold springs and spring runs. Sites are often shaded; the species appears to graze on partly decayed deciduous leaves. May occur with other endemic *Fluminicola* spp.

**Original distribution**: Upper Sacramento R. and Pit R. tributaries in Shasta Co., CA.

**Current distribution**: Six sites at present. Known localities are on private lands (one may be within Shasta National Forest); we anticipate that additional sites in Shasta National Forest, Whiskeytown-Shasta-Trinity National Recreation Area, and areas administered by Lassen National Forest will be found, as some existing sites have federal lands immediately adjacent or are surrounded by such lands. One site is close to DCA CD-83; another appears to be on Shasta National Forest property. Management of nearby DCAs CD-64, 65, 66, 67, & 68 will likely impact this species in part of its range. It is likely to be found on some of the listed DCAs.

**Criteria for inclusion:** Local endemic; occurrence on public lands; proximity to DCA; riparian associate.

**Recommended status**: On present information, should be considered as Threatened in CA and federally; if no more sites are found, the species should be considered Endangered.

**References**: Deixis Consultants, 1991-92.

***Fluminicola* n. sp. 15** flat-top pebblesnail

**Type locality**: Has yet to be designated; taxon not yet formally described.

**Ecology**: Confined to small cold springs and spring sources; substrate ranges from sand to gravel (mostly gravel). A perilithon grazer. May be associated with other endemic *Fluminicola* spp. or with *Juga (O.)* n. sp. 3.

**Original distribution**: Upper Sacramento R. and Pit R. drainages, Shasta Co., CA.

**Current distribution**: Known from 4 sites in the upper Sacramento drainage in Shasta Co., CA. Known sites are on private lands, in some cases interspersed with extensive federal holdings; but most suitable habitat is in Shasta National Forest, areas administered by Lassen National Forest, and Whiskeytown-Shasta-Trinity National Recreation Area. Management of nearby DCAs CD-64, 65, 66, 67, & 68 will likely impact this species in some areas.

**Criteria for inclusion:** Local endemic; probable occurrence on public lands; riparian associate.

**Recommended status**: Should be considered Endangered, both federally and by CA; relatively rare form, and most springs in its range have been utilized or destroyed.

**References**: Deixis Consultants, 1992.

***Fluminicola* n. sp. 16** Shasta pebblesnail

**Type locality**: Will be designated when the species is formally named and described.

**Ecology**: Generally occurs in lower portions of larger cold springs, among *Rorippa* beds and on cobbles and pebbles. May be associated with other endemic *Fluminicola* spp. or with *Juga (O.)* n. sp. 3.

**Original distribution**: Probably a comparatively narrow endemic, spring-restricted form: most likely endemic to the Sacramento R. drainage.

**Current distribution**: Confined to a couple of spring complexes along the upper Sacramento R., Shasta Co., CA, at 11 sites. Most of these are on private lands, but some are on Shasta National Forest property. Management of adjoining DCAs CD-64, 65, 66, 67, & 68 will likely impact this species.

**Criteria for inclusion:** Local endemic; occurrence on public lands; riparian associate.

**Recommended status**: Should be considered Endangered in CA and federally.

**References**: Deixis Consultants, 1992.

***Fluminicola* n. sp. 17** disjunct pebblesnail

**Type locality**: Not yet formally described; type locality will be designated later.

**Ecology**: Lower parts of larger cold springs, on *Rorippa* and large substrate particles. May be associated with other endemic *Fluminicola* spp.

**Original distribution**: Probably a narrow endemic, restricted to the upper part of the Sacramento R. drainage in Shasta Co., CA.

**Current distribution**: Known from three sites in a single, privately-owned spring complex. The area has been affected by railroad usage and resort development. It is quite likely that a few additional sites exist on Shasta National Forest lands. Management of surrounding DCAs CD-64, 65, 66, 67, & 68 will likely impact this species.

**Criteria for inclusion:** Local endemic; occurrence on public lands; riparian associate.

**Recommended status**: This rare form should be listed federally and in CA as Endangered.

**References**: Deixis Consultants, 1992.

***Fluminicola* n. sp. 18** globular pebblesnail

**Type locality**: Will be included as part of the formal description.

**Ecology**: Small cold spring sources and runs, on sides and undersides of stones and wood in shaded areas.

**Original distribution**: Portions of the upper Sacramento and Pit drainages in Shasta Co., CA.

**Current distribution**: Three sites in the upper Sacramento and Pit drainages; one site is in Shasta National Forest, on land included in DCA CD-82. It is likely that a few additional sites will be found in Shasta National Forest and on lands administered by Lassen National Forest. Management of DCAs CD-64, 65, 66, 67, 68, 81, & 82, which are near known sites and may have populations of their own, will likely impact this species.

**Criteria for inclusion:** Local endemic; occurrence on public lands, including a DCA; riparian associate.

**Recommended status:** Likely a rare and restricted narrowly endemic taxon; should be listed as Endangered federally and in CA.

**References:** Deixis Consultants, 1992.

***Fluminicola* n. sp. 19** umbilicate pebblesnail

**Type locality:** None designated as yet; the species will be formally described in the future.

**Ecology:** Found among *Rorippa* and *Veronica* beds and on sandy-gravelly substrate in a large cold spring pool and adjacent spring runs.

**Original distribution:** Probably a very narrow endemic restricted to part of the Pit R. drainage in Shasta Co., CA.

**Current distribution:** Limited thus far to a single spring complex in Lassen National Forest.

**Criteria for inclusion:** Local endemic; occurrence on public lands; riparian associate.

**Recommended status:** Has no special status now. Listing as Endangered Federally and in CA is justified. We have not found the species at other locations in the same creek drainage as the only known site, nor elsewhere in the Pit drainage.

**References:** Deixis Consultants, 1992.

***Fluminicola* n. sp. 20** Lost Creek pebblesnail

**Type locality:** To be designated when the formal description is published.

**Ecology:** Occurs in cold, swift-flowing water in a large spring-fed creek, generally near shore, both on sand-cobble substrate and on aquatic macrophytes and submerged portions of some emergents (*Rorippa*, *Cicuta*); periphyton and perilithon grazer.

**Original distribution:** Probably limited to small portions of the Pit drainage, Shasta Co., CA.

**Current distribution:** Known from a single creek in Lassen National Forest, Shasta Co., CA. This creek has been modified for small-scale hydropower development (PG & E); there are private inholdings on the drainage also.

**Criteria for inclusion:** Local endemic; occurrence on public lands; riparian associate.

**Recommended status:** Currently has no status. Should be listed as Endangered federally and by CA; see above.

**References:** Deixis Consultants, 1991-92.

***Fluminicola seminalis* (Hinds, 1842)** nugget pebblesnail

**Type locality:** Sacramento River below the mouth of American River, CA.

**Ecology**: "Large creeks and rivers" (Taylor, 1981, p. 153); prefers well-oxygenated streams and stable gravel-boulder substrates, regardless of stream size, in the cited range. Generally at low elevations. Often associated with *Lanx patelloides*.

**Original distribution**: Sacramento R. and Pit R., including a few large spring-fed tributaries in northern CA (Shasta, Modoc, and Lassen cos.). A related species is present in parts of the western Klamath drainage, CA-OR (see below).

**Current distribution**: Extinct over most of its former range in the Sacramento R., according to Taylor (1981). Appears to be extirpated in the upper Sacramento R. (only 3 river miles unaffected after July, 1991 metam sodium spill into the river). Collected by us in the Pit R. (CA) system in 1991-92, Shasta Co., CA, including sites in the Shasta National Forest, and sites administered by Lassen National Forest. Known sites are: in Medford District BLM lands; in DCA OD-58; in DCA CD-82 and in or on the edge of DCA CD-81.

**Criteria for inclusion:** Local endemic; occurrence on public lands; occurrence in DCAs; riparian associate.

**Recommended status**: Has none currently. Should be Federal and State (OR, CA) Endangered.

**References**: Taylor (1981); Deixis Consultants 1991-1992.

***Helisoma (Carinifex) newberryi newberryi* (Lea, 1858)** Great Basin rams-horn

**Type locality**: Rising River, Hat Creek, Shasta Co., CA.

**Ecology**: "Larger lakes and slow rivers, including larger spring sources and spring-fed creeks. The snails characteristically burrow in soft mud and may be invisible even when abundant." (Taylor, *op. cit.*). Can occur with *Pisidium ultramontanum*, *Lanx klamathensis*, or several other endemic molluscs.

**Original distribution**: Taylor & Smith (1981) and Taylor (1985) illustrate a total of 14 historic sites for all forms of the species.; 1 in western WY, 3 in southwestern OR; 1 in UT; 7 in northeastern CA; and 2 in eastern CA. Many of these are either now known to be extinct or have not been recollected recently.

**Current distribution**: "In California known from six local drainages, in which the species survives in probably only four....Sheepy Creek [Siskiyou County; may now (1991) be extinct]...Pit River, including the large spring-pools and their outflows of Fall River and Hat Creek; known downstream to above Squaw Creek, but probably extinct in the lower segment of its range. Eagle Lake, Lassen County. Lake Tahoe and adjacent slow segment of its outflow, Truckee River...." (Taylor, 1981, p. 158). The UT (Utah Lake) and Owens Valley, CA populations are extinct. Some of the CA and OR sites are within the range of the Northern Spotted Owl. Surviving sites are in Winema National Forest, Upper Klamath Lake National Wildlife Refuge and in Lassen National Forest (*e.g.* Eagle Lake); others may be located on BLM lands in the vicinity of Fall River Mills, CA. At least one site is within DCA OD-58.

**Criteria for inclusion:** Local endemic; occurrence on public lands, including a DCA; riparian associate.

**Recommended status**: Currently has none. Should be Federal and State (OR and CA) Endangered. The WY subspecies (*jacksonense*), regarded by Burch (1989) as taxonomically distinct, is a Federal Category 2 candidate (USFWS, 1991).

**References:**Taylor (1981); Deixis Consultants, 1989-1992.

***Juga (Calibasis) acutifilosa*** **(Stearns, 1890)** scalloped juga

**Type locality**: '"Eagle Lake," actually the nearby head of Willow Creek, Lassen County, California' (Taylor, 1981, p. 148).

**Ecology**: "Large springs and their outflows, often narrowly restricted to the source area" (Taylor, op. cit. ). Occurs only in unpolluted, cold, well-oxygenated water, generally with stable gravel substrate. Low to medium elevations. Often occurs with other endemic molluscs, such as *Fluminicola* spp.

**Original distribution**: Reported from eight isolated populations in large spring complexes, most in northern CA, with one population in an OR spring complex.

**Current distribution**: Taylor (1981) reports that the species is only known in CA to occur in seven spring complexes and believes few if any additional populations will be found. The number of now-extant populations is uncertain. Most populations are to the east of the Spotted Owl's range, but at least 2 in CA and 1 in OR are within it. The species occurs primarily in the Klamath drainage, Jackson Co., OR and Siskiyou Co., CA; , and in the Pit drainage, CA (Shasta Co., Lassen Co.). A few populations also occur on the periphery of the Great Basin in CA (Modoc and Lassen cos.). Some sites are on National Forest lands, *i.e.*Modoc National Forest and Lassen National Forest, or on state lands, *e.g.* Ahjumawi Lava Springs State Park. A small number of additional sites are likely on BLM lands in the Fall River Mills area and in Lassen National Forest east of Hat Creek. The Jackson Co., OR site is partly on Medford District BLM lands and is a few miles east of DCA OD-22.

**Criteria for inclusion:** Local endemic; occurrence on public lands; proximity to a DCA; riparian associate.

**Recommended status**: Has none at present. Should be Federal Threatened and State (CA, OR) Endangered.

**References**: Clarke (1976); Taylor (1981); Burch (1989); Deixis Consultants, 1991-92.

***Juga (Calibasis) occata*** **(Hinds, 1844)** topaz juga

**Type locality**: Sacramento R. between American R. and mouth, CA.

**Ecology:** Large stream and river form. Restricted to swift, unpolluted, well-oxygenated areas with gravel-boulder substrate, generally at low elevations. Often found with *Lanx patelloides* or other rare mollusc species.

**Original distribution**: Sacramento R. and Pit R. of northern CA. Specimens collected by H. Hemphill from the upper Sacramento R. prior to 1940 were recently located in the collections of the California Academy of Sciences. Only a few sites known.

**Current distribution**: "Surviving in the lower Pit River, but status in the Sacramento River unknown-no records in the present century. Change in the riverbed due to extensive placer-mining in the last century might have eliminated it in most of the Sacramento River" (Taylor, 1981, p. 149). Only three river miles in the upper Sacramento R. survive relatively unaffected after the July, 1991 toxic spill; we found the species to be extirpated there; but it still survives in a few widely separated sites in the Pit R. below the Falls in Shasta Co., CA, including sites in Shasta National Forest, including area in DCA CD-82. Additional sites (in limited numbers) are likely in Shasta National Forest and in lands administered by Lassen National Forest, *e.g.* east of Rising R.

**Criteria for inclusion:** Local endemic; occurrence on public lands, including a DCA; riparian associate.

**Recommended status**: At present, has none. Should be Federal and State (CA) Endangered.

**References**: Taylor (1981); Burch (1989); Deixis Consultants, 1991-92.

***Juga (Juga) hemphilli dallesensis*** **(Henderson, 1935)** Dalles juga

**Type locality**: Mill Creek, The Dalles, Wasco Co., OR.

**Ecology**: Large springs and small-medium creeks, always at low elevations; stable gravel substrate, but fast-flowing, unpolluted, highly oxygenated, cold water.

**Original distribution**: Uncertain. Probably in the central-eastern Columbia Gorge, WA-OR.

**Current distribution**: Most of Mill Creek has succumbed to urbanization and agricultural pollution. The species still survives in a small part of Mill Creek. A few isolated populations in the central and eastern Columbia Gorge from Hood River to The Dalles, WA-OR; more specifically Hood River and Wasco cos., OR and Skamania Co., WA , including sites in Mt. Hood and Gifford Pinchot National Forests and the Columbia Gorge National Scenic Area. At least one site is apparently on DCA OD-1; others are near the border of DCA WD-1.

**Criteria for inclusion:** Local endemic; occurrence on public lands, including a DCA; riparian associate.

**Recommended status**: Currently has none. Should be listed Federally and State (WA, OR) as Endangered.

**References**: Henderson (1935, 1936); Burch (1989). Deixis Consultants, 1987-1991.

***Juga (Juga) hemphilli hemphilli*** **(Henderson, 1935)** barren juga

**Type locality**: Portland, Multnomah Co., OR; where uncertain, possibly Johnson Creek.

**Ecology**: Small-medium creeks, generally at low elevations. Found only in level-bottom, highly oxygenated, cold-water streams, unpolluted and with stable gravel-boulder substrate.

**Original distribution**: Uncertain. Sporadic in some of the small drainages on the west end of the Columbia Gorge, WA-OR, east of the Willamette R.

**Current distribution**: Type locality (if it was Johnson Creek) still viable. Still survives in a few isolated Columbia Gorge populations in WA and OR, in mostly urbanized areas: Clark and Skamania cos., WA and Multnomah Co., OR, including sites in the Columbia River National Scenic Area and Mt. Hood National Forest. May range onto Gifford Pinchot National Forest also. Sites are included within the borders of DCA OD-1.

**Criteria for inclusion:** Local endemic; occurrence on public lands, including a DCA; riparian associate.

**Recommended status**: Has no special status currently. Should be listed Federally and State (WA, OR) as Endangered.

**References**: Henderson (1935, 1936); Burch (1989); Deixis Consultants, 1986-1992.

***Juga (Juga) hemphilli* n. subsp.** no common name

**Type locality**: None designated as yet.

**Ecology**: Small-medium streams and large springs. Generally on stable gravel substrate, but can live on mud. Requires cold, unpolluted, fast-flowing, well-oxygenated water in level-bottom streams at low elevations.

**Original distribution**: Western Columbia Gorge, WA-OR.

**Current distribution**: A few isolated occurrences at low elevations in the western Columbia Gorge; west of the Willamette R. in OR; and in the vicinity of Washougal, WA. Sites are in Clark Co., WA and Multnomah Co., OR, including ones in the Columbia Gorge National Scenic Area. This species likely ranges onto Mt. Hood National Forest and Gifford Pinchot National Forest.

**Criteria for inclusion:** Local endemic; occurrence on public lands; proximity to DCA OD-1; riparian associate.

**Recommended status**: None currently. Should be listed Federally and State (WA, OR) as Endangered.

**References**: Deixis Consultants, 1987-1991.

***Juga (Juga)* n. sp. 1** brown juga

**Type locality**: None designated as yet.

**Ecology**: Small streams and springs, including spring sources, western and central Columbia Gorge, WA-OR. Prefers cold, fast-flowing well-oxygenated water and gravel substrate: most frequently found in very small and shallow but perennial spring-fed streams and springs. Often narrowly localized in such drainages and restricted to small springs and spring sources, generally at low to medium elevations.

**Original distribution**: Uncertain. Most likely the western two-thirds of the Columbia Gorge.

**Current distribution**: Sporadic in several Columbia Gorge streams and associated springs, especially on the WA side, in the western end of the Gorge. Also occurs at one or two sites in the central Gorge, Skamania Co., WA and Multnomah and Hood River cos., OR, including sites in the Columbia Gorge National Scenic Area and Mt. Hood National Forest. Likely occurs in Gifford Pinchot National Forest also; may occur on DCA OD-1.

**Criteria for inclusion:** Local endemic; occurrence on public lands; proximity to DCA; riparian associate.

**Recommended status**: None currently. Should be listed Federally and State (WA, OR) as Endangered.

**References**: Deixis Consultants, 1988-1991. This taxon could include the type specimens (and one or two museum lots) of "*Juga (O.) draytoni* (Lea)", but the diagnostic characters are not preserved on Lea's types, which may thus constitute an unrecognizable species.

***Juga (Juga)* n. sp. 3** tall juga

**Type locality**: None has been designated; species undescribed.

**Ecology**: Small-medium-sized streams, equally on mud or gravel substrates; always in level-bottom, well-oxygenated, cold, unpolluted, fast-flowing streams at low elevations.

**Original distribution**: Uncertain: probably confined to the western Columbia Gorge.

**Current distribution**: Now confined to 3 or 4 small creeks in the Mt. Hood area, western Columbia Gorge, OR, including sites in Mt. Hood National Forest (some on DCA OD-1) and in the Columbia Gorge National Scenic Area (Multnomah and Hood River cos.). May also occur in Gifford Pinchot National Forest.

**Criteria for inclusion:** Local endemic; occurrence on public lands, including a DCA; riparian associate.

**Recommended status**: Presently has none. Should be listed Federally and State (OR) as Endangered.

**References**: Deixis Consultants, 1987-1991.

***Juga (Oreobasis) chacei* (Henderson, 1935)** Chace juga

**Type locality**: "Small tributary of Smith River, Adams Station, Del Norte Co., California" (Taylor, 1981, p. 149).

**Ecology**: Small-very small permanent streams at low to middle elevations, generally on gravel substrate, always in cold, clear, highly oxygenated, unpolluted, running water.

**Original distribution**: Drainage of the Smith R. and a few surrounding creeks, all in Del Norte Co., CA.

**Current distribution**: Still survives sporadically in the limits of the original distribution, which includes sites in Six Rivers National Forest. Old sites are in DCA CD-1, CR-1A, and possibly CD-29 and OD-26.

**Criteria for inclusion:** Local endemic; occurrence on public lands, including DCAs; riparian associate.

**Recommended status**: None at present. Suggested Federal and CA status: Endangered.

**References**: Henderson (1935); Taylor (1981); Deixis Consultants, 1991.

***Juga (Oreobasis)* n. sp. 1** no common name

**Type locality**: None has been designated as yet.

**Ecology**: Small-medium streams, large springs. Can occur on both mud and gravel bottom, but always in spring-fed streams and large springs with level bottom, cold water, fast flow, and high dissolved $O_2$. Low-mid elevations.

**Original distribution**: Central and eastern Columbia Gorge.

**Current distribution**: Uncommon in a few of the central and eastern Columbia Gorge tributaries, WA only, Skamania and Klickitat cos., including sites in Gifford Pinchot National Forest and Columbia Gorge National Scenic Area. Some sites are in or near the border of DCA WD-1.

**Criteria for inclusion:** Local endemic; occurrence on public lands, probably including a DCA; riparian associate.

**Recommended status**: Currently has none. Should be listed federally and State (WA) as Threatened.

**References**: Deixis Consultants, 1987-1991.

***Juga (Oreobasis)* n. sp. 2** no common name

**Type locality**: Species undescribed; none designated as yet.

**Ecology**: Central and eastern Columbia Gorge; restricted to springs in small drainages tributary to the Columbia R., at low elevations. Prefers gravel substrate and requires unpolluted water; mostly in very small and shallow but permanent, undisturbed springs.

**Original distribution**: Uncertain; recently discovered taxon. Probably central and eastern Columbia Gorge only.

**Current distribution**: Sporadic in springs in the central and eastern portions of the Columbia Gorge, OR side only: Hood River and Wasco cos., OR, including sites in Mt. Hood National Forest and sites in Columbia Gorge National Scenic Area. Some sites likely in DCA OD-1.

**Criteria for inclusion:** Local endemic; occurrence on public lands; proximity to DCA; riparian associate.

**Recommended status**: None currently. Should be listed Federally and State (OR) as Threatened.

**References**: Deixis Consultants, 1988-93. One very old museum lot (NMNH) may be this species.

***Juga (Oreobasis)* n. sp. 3** no common name

**Type locality**: Species undescribed; none designated as yet.

**Ecology**: Occurs in large cold springs and spring runs, with sand-cobble substrate, in forested area, along with one or more endemic *Fluminicola* spp.

**Original distribution**: Uncertain; recently discovered taxon. Probably upper Sacramento R. only.

**Current distribution**: Three sites in springs in a large complex along the upper Sacramento R., Shasta Co., CA. Localities are very near to elements of Shasta National Forest. It is possible that a few additional sites exist on Shasta National Forest lands. Management of surrounding DCAs CD-64, 65, 66, 67, & 68 will likely impact this species.

**Criteria for inclusion:** Local endemic; proximity to public lands and DCAs; riparian associate.

**Recommended status**: None currently. Should be listed Federally and State (CA) as Endangered.

**References**: Deixis Consultants, 1992. One old museum lot (UMMZ) is this species.

***Juga (Oreobasis) orickensis* (Henderson, 1935)** redwood juga

**Type locality**: Redwood Creek, Orick, Humboldt Co., CA.

**Ecology**: Small spring-fed permanent rivulets to creeks, often on gravel bottom, always in unpolluted, clear, cold, running water. High to low elevations.

**Original distribution**: In coastal streams in southern Curry Co., OR and in Del Norte, Humboldt, and western Trinity cos., CA.

**Current distribution**: Sporadic in relatively undisturbed habitat within its original range, which includes sites in Siskiyou, Six Rivers, and Trinity National Forests and in Redwood National Park (type locality). Old sites appear to be on DCAs OD-26, CD-1, 2, 29, 35, 45, 46, & 51.

**Criteria for inclusion:** Local endemic; occurrence on public lands, including DCAs; riparian associate.

**Recommended status**: None currently. On present information should be listed as Threatened federally and in OR and CA.

**References**: Henderson (1935, 1936); Taylor (1981); Deixis Consultants, 1991.

***Lanx alta* (Tryon, 1865)** highcap lanx

**Type locality**: Klamath River (no specific locality).

**Ecology**: "Large rivers and major tributaries, on boulders or rock in current" [Taylor (1981, p. 157)]. Low to medium elevations; the species is a perilithon feeder found in areas with stable cobble-boulder substrate and excellent water quality.

**Original distribution**: "Drainages of Umpqua and Klamath rivers, OR, to South Fork of Trinity River (tributary to Klamath River), California; Smith River, California" (Taylor, 1981, p. 157). Counties are Josephine, Jackson, and Curry on the Rogue R. (including sites in Siskiyou National Forest: sites in Rogue River National Forest may be extirpated); and Del Norte, Humboldt, and Siskiyou cos. [CA], plus Klamath Co., OR (Klamath R.). Old sites were in Winema, Klamath, Six Rivers, and Trinity National Forests. Some of these sites are known to survive. DCAs involved are CD-32, 35, 51, & 62; the species also occurs near to the borders of CD-30, 31, 33, & 46, and in the Rogue National Wild and Scenic River.

**Current distribution**: Recently (1991-2) collected alive by us in the Klamath R. in CA and Rogue R. in OR; now extinct in most of the Klamath R. and part of the Rogue R.; status in other rivers in its range uncertain. Umpqua specimens are better assigned to *L. subrotundata* (*q.v.*).

**Criteria for inclusion:** Local endemic; occurrence on public lands, including DCAs; riparian associate.

**Recommended status:** Currently has none. Should be State (CA, OR) Threatened; Federal status uncertain.

**References**: Burch (1989); Taylor (1981); Deixis Consultants, 1991-92.

***Lanx klamathensis* Hannibal, 1912** scale lanx

**Type locality**: South end of Upper Klamath Lake, Klamath Falls, Klamath Co., OR.

**Ecology**: A form restricted to large, spring-fed lakes and streams and limnocrene springs. The species, like all lancids, is an obligate perilithon grazer, and occurs on cobbles and boulders, generally in areas with current and always at sites with oxygenated, high quality water. This species commonly occurs with a variety of other rare forms, including *Pyrgulopsis archimedis*, *Pyrgulopsis* n. sp. 1, *Lyogyrus* spp., *Fluminicola* spp., and *Vorticifex klamathensis klamathensis*.

**Original distribution**: Upper Klamath Lake basin, Klamath Co., OR and Siskiyou Co., CA, likely including Lower Klamath Lake and Tule Lake as well as Upper Klamath Lake. Occurrence in Lake of the Woods uncertain.

**Current distribution**: Survives at a few spring-buffered sites in the Upper Klamath Lake, area, including the Link River and localities in Winema National Forest and Upper Klamath Lake National Wildlife Refuge. The Tule Lake population (Tule Lake National Wildlife Refuge) may be extinct. Other sites are possible in the same areas and in Rogue River National Forest. At least one site is believed to be in or just peripheral to DCA OD-58.

**Criteria for inclusion:** Local endemic; occurrence on public lands, including a DCA; riparian associate.

**Recommended status**: None at present. This species should be considered Endangered in the states of OR and CA and federally.

**References**: Taylor (1981); Burch (1989); Deixis Consultants, 1991-92.

***Lanx patelloides* (Lea, 1856)** kneecap lanx

**Type locality**: "Sacramento River (no specific locality), California" (Taylor, 1981, p. 157).

**Ecology**: "Larger rivers and major tributaries, on firm substratum in slow to moderate current" (Taylor, *op. cit.* ). Low to medium elevations. Can also occur in large springs with exceptional water quality and rarely in spring-fed creeks. often found at sites with other rare mollusc species, such as *Juga occata* and *Juga acutifilosa*.

**Original distribution**: "Pit River below the falls; Sacramento River from Pit River downstream to Mill Creek, Tehama County; and lower parts of larger streams tributary to both rivers" (Taylor, *op. cit.*). Museum records also from the upper Sacramento system. Taylor (unpublished) shows a total of 16 historical sites for this species: half were in the upper Sacramento system. Well-documented sites were in Shasta and Tehama cos., CA.

**Current distribution**: Uncertain. The Sacramento R. populations below Shasta Lake are largely extirpated, and the status of those above Shasta Lake is now uncertain (main river sites are extinct; one tributary population survives). Recently (1991-92) collected by us in the Pit system, Shasta Co., CA, including sites in Shasta National Forest and in areas administered by Lassen National Forest. Occurrence on one DCA (CD-82) is confirmed.

**Criteria for inclusion:** Local endemic; occurrence on public lands, including a DCA; riparian associate.

**Recommended status**: Has none at present. Should be Federal and State (CA) Endangered.

**References**: Taylor (1981); Deixis Consultants, 1991-92.

***Lanx subrotundata* (Tryon, 1865)** rotund lanx

**Type locality**: Umpqua R., OR (no specific site).

**Ecology**: Larger rivers and major tributaries, generally in swift current on rocky (gravel-boulder) substrate, in unpolluted, $O_2$-rich streams. Low to medium elevations.

**Original distribution**: Umpqua R. and its major tributaries, Douglas Co., OR.

**Current distribution**: Portions of the Umpqua R. system, where unaffected by pollution, lumbering-induced changes, or impoundments. Many old sites are in areas administered by the BLM (Coos Bay and Roseburg Districts); some are in Umpqua National Forest. Some of these have recently been confirmed to survive. Definitely involved DCAs include OD-32, 34, 36, & 16.

**Criteria for inclusion:** Local endemic; occurrence on public lands, including DCAs; riparian associate.

**Recommended status**: None currently. Should be considered Federal and State (OR) Endangered.

**References**: Burch (1989); Deixis Consultants, 1989-92.

***Lyogyrus* n. sp. 1** Columbia duskysnail

**Type locality**: None designated as yet.

**Ecology**: Springs and spring outflows, from low to high elevations, in cold, pure, well-oxygenated water. Often in very small springs; most common on soft substrates, in shallow, rather slow flows. Prefers oligotrophic pristine flowages with no macrophytes, but can be found in larger springs with *Rorippa* and *Cicuta*. Sometimes found with other Species of Special Concern, such as *Juga (O.)* spp.

**Original distribution**: Unknown: discovered recently. Probably a Columbia Gorge endemic.

**Current distribution**: Very sporadic in the central and eastern Columbia Gorge, WA and OR. About a dozen sites are known from private lands and from the Columbia Gorge National Scenic Area, Gifford Pinchot National Forest, and Mt. Hood National Forest, Klickitat and Skamania cos., WA, and Multnomah and Hood River cos., OR. Some sites are in state parks (Beacon Rock, Benson, Wahkeena Falls) or in DCA OD-1. This species is associated with federal listing candidate arthropods at some localities.

**Criteria for inclusion:** Local endemic; occurrence on public lands, including a DCA; riparian associate.

**Recommended status**: Currently has none. Should be Federal and State (WA, OR) Endangered.

**References**: Deixis Consultants, 1988-1991.

***Lyogyrus* n. sp. 2** Washington duskysnail

**Type locality**: None as yet; undescribed taxon.

**Ecology**: Kettle lakes on periphery of the Columbia drainage in WA, in areas heavily affected by Late Pleistocene glaciation. This limnetic species occurs on oxygenated mud substrates in areas with some aquatic macrophytes (*Potamogeton crispus*, *Elodea*, *Myriophyllum spicatum*, *Ceratophyllum densum*, *Chara*). Sizable numbers of waterlogged deciduous leaves (*Alnus*, *Populus*) are always present. Occurs with another rare endemic (outside the range of the Northern Spotted Owl), *Amnicola* n. sp. 1 at one site.

**Original distribution**: Probably quite common at one point in northern and central WA on the east side of the Cascades east to the Rockies, in heavily glaciated valleys, in Pend d'Oreille, Stevens, Ferry, Okanogan, and Chelan counties, WA.

**Current distribution:** Known from two lakes, one in Ferry Co. and the other in Wenatchee National Forest, Chelan Co., WA. The Chelan Co. site should be included in DCA WD-33.

**Criteria for inclusion:** Local endemic; occurrence on public lands; riparian associate.

**Recommended status:** Has none currently. On present evidence, should be listed as Endangered both federally and in WA.

**References:** Clarke (1976b); Deixis Consultants, 1988-93.

***Lyogyrus* n. sp. 3** canary duskysnail

**Type locality:** None designated as yet; recently discovered species.

**Ecology:** Occurs on undersides of loose but stable cobbles and boulders in very large spring; many rocks with abundant encrusting red algae; most common in water less than 4' deep. Appears to be photophobic. Occurs with other Species of Special Concern, *e.g. Vorticifex* n. sp. and *Juga acutifilosa.*

**Original distribution:** Uncertain; likely confined to major spring complexes in the Pit drainage; a sister species occurs in slightly different habitat in the Klamath drainage, OR. Probably confined to parts of Shasta, Lassen, and Modoc cos., CA.

**Current distribution:** Known from a single site in Shasta Co, near the present boundary of Shasta National Forest. Other sites are possible in limited areas on BLM lands and in Lassen and Shasta National Forests in the vicinity of Fall River Mills.

**Criteria for inclusion:** Local endemic; possible occurrence on public lands; riparian associate.

**Recommended status:** Has none at present. Should be listed as Endangered federally and by the State of CA.

**References:** Deixis Consultants, 1990-92.

***Lyogyrus* n. sp. 4** Klamath duskysnail

**Type locality:** Undescribed taxon; none yet designated.

**Ecology:** Lives on undersides and sides of boulders and cobbles in large lake, in areas with spring influence. Macrophytes generally absent; the species is photophobic. Can occur with other rare mollusc taxa, such as *Lanx klamathensis, Pyrgulopsis archimedis, Pyrgulopsis* n. sp. 1, and *Vorticifex klamathensis klamathensis.*

**Original distribution:** Upper Klamath Lake (both sides), including the Link River, Klamath Co., OR.

**Current distribution:** Known to survive at about 4 sites, all somewhat sheltered from eutropification by spring influx, on private land and in Upper Klamath Lake National Wildlife Refuge and Winema National Forest. Other sites are possible in the same areas. Two sites are either in, or on the edge of, DCA OD-58.

**Criteria for inclusion:** Local endemic; occurrence on public lands, probably including a DCA; riparian associate.

**Recommended status:** None at present; should be listed as Endangered federally and by state of OR. Sites are threatened by eutropification, urban and industrial pollution, and habitat modification to accommodate Endangered sucker species.

**References:** Taylor (1985); Deixis Consultants, 1990-92.

***Lyogyrus* n. sp. 5** nodose duskysnail

**Type locality:** Recently discovered taxon; none as yet.

**Ecology:** Occurs on undersides and sides of cobbles and boulders in spring complex draining into Upper Klamath Lake and rarely in spring-influenced outflow from lake; *Rorippa* present, but snails on rocks only; species appears photophobic. Occurs with other Species of Special Concern, including *Pyrgulopsis archimedis*, *Pyrgulopsis* n. sp. 1, *Lanx klamathensis*, and *Vorticifex klamathensis klamathensis*.

**Original distribution:** Upper Klamath Lake and major spring tributaries, Klamath Co., OR.

**Current distribution:** Known from two sites on Upper Klamath Lake, one in Winema National Forest; very rare at one site. A few other sites are possible in the Upper Klamath Lake basin, *e.g.* Upper Klamath Lake National Wildlife Refuge, DCA OD-58.

**Criteria for inclusion:** Local endemic; occurrence on public lands; riparian associate.

**Recommended status:** Has none at present. The species should be listed as Endangered federally and by state of OR. Sites are threatened by eutropification, urban and industrial pollution, and habitat modification to accommodate Endangered sucker species.

**References:** Deixis Consultants, 1992.

***Lyogyrus* n. sp. 6** mare's egg duskysnail

**Type locality:** Recently discovered, undescribed taxon; none yet designated.

**Ecology:** Occurs on undersides of cobbles and boulders and of very large *Nostoc* colonies (locally termed mare's eggs) in spring-influenced sites in a large lake. Can occur with other species of Special Concern, such as *Lanx klamathensis*.

**Original distribution:** Upper Klamath Lake and vicinity, Klamath Co., OR; riparian associate.

**Current distribution:** So far found at 2 sites only, one on private land interfingered with units of Winema National Forest and Upper Klamath Lake National Wildlife Refuge and the other apparently on Winema National Forest lands. A small number of additional sites could exist, in the areas mentioned previously (which includes DCA OD-58) and Upper Klamath Lake National Wildlife Refuge.

**Criteria for inclusion:** Local endemic; occurrence on public lands, including a DCA.

**Recommended status:** Should be a federal and State of OR Endangered species. Upper Klamath Lake is badly eutropified, and this species seems to occur only in relatively unpolluted areas with strong, permanent spring influence. These are also commonly sucker spawning sites, hence subject to modification to enhance habitat for three listed Upper Klamath Lake fish species.

**References:** Deixis Consultants, 1992.

***Physella (Physella) columbiana*** **(Hemphill, 1890)** rotund physa

**Type locality:** Lower Columbia River at The Dalles, Wasco Co., OR.

**Ecology:** Nothing certain in the literature; A large-river physid, probably restricted to relatively pure, deep, well-oxygenated water. Substrate preference unknown; likely gravel-boulders. Low elevations only.

**Original distribution:** Probably endemic to the lower Columbia River, likely from The Dalles to its mouth: Wahkiakum, Cowlitz, Clark, Skamania, and Klickitat cos., WA and Clatsop, Columbia, Multnomah, Hood River, and Wasco cos., OR. About half of the range is in the Columbia River Gorge National Scenic Area.

**Current distribution:** Uncertain; could be extinct. This species is one of several likely driven to extinction or near extinction, either throughout their range or in a major part of it, from BPA dams and their effects. The others are *Vorticifex neritoides, Fisherola nuttalli, Fluminicola columbiana, Anodonta californiensis, Anodonta wahlametensis,* and an undescribed *Pyrgulopsis.* We know of no recent records for *columbiana.* However, some rocky habitat does survive in limited areas, and survival of *F. nuttalli* has recently been confirmed. Several lots in museum collections were examined by us in 1991. The references to occurrences in WY and MT in Burch (1989) derive from Te (1978) and are incorrect, in our opinion. Only lower Columbia specimens match the type specimens.

**Criteria for inclusion:** Local endemic; possible occurrence on public lands; riparian associate.

**Recommended status:** Has none at present. Should be Federal and State (WA, OR) Endangered.

**References:** Taylor (1985); Deixis Consultants, 1988-1991.

***Pyrgulopsis archimedis*** Berry, 1947 Archimedes pyrg

**Type locality:** Upper Klamath Lake in vicinity of Algoma, Klamath Co., OR.

**Ecology:** Large-lake hydrobiid, now surviving only in areas with spring influence to counter eutropification and subsequent periodic low DO. This taxon prefers areas with gravel-boulder substrate and few macrophytes. It occurs with several other Species of Special Concern, namely *Lanx klamathensis, Pyrgulopsis* n. sp. 1, *Pisidium ultramontanum, Lyogyrus* n. sp. 4, *Fluminicola* n. sp. 1, and *Vorticifex klamathensis klamathensis.*

**Original distribution:** Upper Klamath Lake and Tule Lake, Klamath Co., OR and Siskiyou Co., CA; likely occurred also in Lower Klamath Lake as well. The related (and now likely extinct) genotype *P. nevadensis* occurred in Walker and Pyramid Lakes, NV.

**Current distribution:** Known now from 4 spring-influenced sites in Upper Klamath Lake, Klamath Co., OR. Two sites are in Winema National Forest. Sites in Upper Klamath Lake National Wildlife refuge are probable. The Tule Lake population is likely extinct.

**Criteria for inclusion:** Local endemic; occurrence on public lands; proximity to DCA OD-58; riparian associate.

**Recommended status:** Should be listed by the federal government and state of OR as Endangered. Upper Klamath Lake is badly eutropified, and this species seems to occur only in relatively unpolluted areas with strong, permanent spring influence. These are also commonly sucker spawning sites, and hence subject to modification to enhance habitat for three listed Upper Klamath Lake species.

**References**: Deixis Consultants, 1992.

***Pyrgulopsis intermedia*** (Tryon, 1865) Crooked Creek springsnail

**Type locality**: Crooked Creek, Malheur Co., OR.

**Ecology**: Occurs primarily in large springs, but also in spring-influenced creeks and rivers, generally with gravel-boulder substrate. May be found with other Species of Special Concern, such as *Helisoma newberryi* and *Lanx patelloides*.

**Original distribution**: Periphery of the Great Basin along old course of the Snake River, *i.e.* from the OR-ID border to northern CA (in the Pit drainage); Harney, Malheur, and possibly Lake and Klamath cos. OR and Shasta, Lassen, and Modoc cos., CA.

**Current distribution**: Known from about eight scattered sites in Harney and Malheur cos., OR (on private and BLM lands), and from Shasta Co., CA (private, and apparently sites in Shasta National Forest). May occur also on lands administered by Lassen National Forest. One site is on DCA CD-82.

**Criteria for inclusion**: Local endemic; occurrence on public lands, including a DCA; riparian associate.

**Recommended status**: None at present. Should be considered Endangered in CA; federal status uncertain and requires further fieldwork, but probably should be listed. Most old sites have been extirpated.

**References**: Henderson (1929, 1935); Taylor (1981); Deixis Consultants, 1989-92.

***Pyrgulopsis* n. sp. 1** lake pyrg

**Type locality**: New species, none designated at present.

**Ecology**: Found on cobbles and boulders in spring-influenced areas of a large lake. It occurs with several other Species of Special Concern, namely *Lanx klamathensis*, *Pyrgulopsis archimedis*, *Pisidium ultramontanum*, *Lyogyrus* n. sp. 4, and *Vorticifex klamathensis klamathensis*.

**Original distribution**: Upper Klamath Lake, Klamath Co., OR.

**Current distribution**: Known to survive at two sites, both on private land on the east side of the lake. One site is in Winema National Forest. Other sites are possible in the vicinity.

**Criteria for inclusion**: Local endemic; occurrence on public lands; riparian associate.

**Recommended status**: Should be considered Endangered by both the federal government and State of CA. The species lives only in the limited areas of the lake not affected by eutropification as they have spring influx. These sites are spawning areas for three Endangered sucker species and hence may be modified as part of recovery actions for the fish.

**References**: Deixis Consultants, 1991-92.

***Vorticifex klamathensis klamathensis* (Baker, 1945)** we suggest Klamath rams-horn

**Type locality:** None designated ; apparently Upper Klamath Lake, head of Link R., Klamath Co., OR (Baker, 1945).

**Ecology:** Lives on cobbles and boulders in flowing water in spring-influenced streams and a large lake. It occurs with several other Species of Special Concern, namely *Lanx klamathensis, Pyrgulopsis* n. sp. 1, *Pyrgulopsis archimedis, Pisidium ultramontanum, Fluminicola* n. sp. 1, and *Lyogyrus* n. sp. 4.

**Original distribution:** Upper Klamath Lake, Klamath Co., OR; may occur in suitable habitat in other lakes and streams in the same drainage.

**Current distribution:** Known from a few sites in Upper Klamath Lake and its major tributaries (including one site in Winema National Forest, near or in DCA OD-58).

**Criteria for inclusion:** Riparian associate; local endemic; occurrence on public lands, including a DCA; riparian associate.

**Recommended status:** Should be listed as Endangered federally and by the State of OR; currently has no special status.

**References:** Baker (1945); Deixis Consultants, 1991-92.

***Vorticifex klamathensis sinitsini* (Baker, 1945)** we suggest Sinitsin rams-horn

**Type locality:** None designated; Barclay Springs, Upper Klamath Lake, Klamath Co., OR.

**Ecology:** Found on cobbles and boulders in a large cold spring, generally not in areas with abundant macrophytes. Occurs with *Lanx* sp.

**Original distribution:** Known at present only from a single site, as above. Likely to occur in other springs in the same region.

**Current distribution:** See above.

**Criteria for inclusion:** Local endemic; probable occurrence on adjoining public lands (Winema National Forest, Upper Klamath Lake National Wildlife Refuge); riparian associate. The spring is being modified currently to enhance listed fish species' spawning habitat.

**Recommended status:** Has none at present. Should probably be considered Endangered both by the federal government and by OR.

**References:** Baker (1945); Deixis Consultants, 1991-92.

***Vorticifex* n. sp. 1** knobby rams-horn

**Type locality**: None has yet been designated; new species.

**Ecology**: Found only at two sites in limited areas of a very large, pristine spring complex and its outflow, on rocky substrate; very cold and clear water with saturated DO and swift flow. Occurs with *Juga acutifilosa* , *Lyogyrus* n. sp. 3, and *Lanx patelloides.*

**Original distribution**: Likely confined recently to large spring complexes tributary to the Pit R. in Shasta, Modoc, and Lassen cos., CA. Similar fossil species are known from the periphery of the Great Basin in NV, OR, and CA.

**Current distribution**: Found only at two sites in Shasta Co., CA, on private land adjoining Shasta National Forest. Limited numbers of additional sites are possible in Shasta National Forest, on lands administered by Lassen National Forest, and on state-owned lands near Fall River Mills.

**Criteria for inclusion:** Local endemic; possible occurrence on public lands; riparian associate.

**Recommended status**: This species should be listed as Endangered, both federally and by the State of CA; very few similar sites now exist that have not been sampled. Most large Pit R. spring complexes have been polluted or modified for hatcheries or for hydropower projects. It occurs with the Endangered *Pacifastacus fortis* at one site.

**References**: Deixis Consultants, 1991-92.

***Vorticifex neritoides*** **(Hemphill, 1890)** nerite rams-horn

**Type locality**: Lower Columbia R., probably at The Dalles, Wasco Co., OR.

**Ecology**: Uncertain; rarely found. Probably unpolluted, rocky bottom, in somewhat swift flow, highly oxygenated water, and stable substrate, in relatively unimpounded stretches. Low elevations only.

**Original distribution**: Lower Columbia R.; museum records extend from The Dalles to the river mouth, in the following areas: Wahkiakum, Cowlitz, Clark, Skamania, and Klickitat cos., WA and Clatsop, Columbia, Multnomah, Hood River, and Wasco cos., OR.

**Current distribution**: Likely extinct at the type locality. Collected by us from one site on the WA side of the Columbia in 1988. Another species heavily impacted by lower Columbia R. dams: see comments under *Physella columbiana*.

**Criteria for inclusion:** Local endemic; possible occurrence on public lands; riparian associate.

**Recommended status**: Currently, has none. Should be Federal and State (WA, OR) Endangered. Very little unmodified rocky habitat is left in the lower Columbia R., due to siltation, pollution, and habitat modification induced by construction and operation of BPA dams and impoundments.

**References**: Baker (1945); Taylor (unpublished); Taylor (1985); Deixis Consultants, 1988.

## Freshwater Clams

***Anodonta californiensis*** **Lea, 1852** California floater

**Type locality**: '"Rio Colorado," actually a former distributary of the river, approximately New River, Imperial County, California. " (Taylor, 1981, p. 142).

**Ecology**: "Lakes and slow rivers" (Taylor, 1981, p. 142), generally on soft substrates (mud-sand), in fairly large streams and lakes only, in relatively slow current. A low elevation species.

**Original distribution**: Lower Willamette and lower Columbia rivers in OR and WA from The Dalles to the mouth. In larger slow streams of northern CA as far south as the northern San Joaquin Valley. The former range includes Wahkiakum, Cowlitz, Clark, Skamania, and Klickitat cos., WA; Clatsop, Columbia, Multnomah, Hood River, and Wasco cos., OR; and Siskiyou, Shasta, Lassen, Modoc, and Tehama cos., CA.

**Current distribution**: Taylor (1981) reports that this species is probably eradicated over much of its original range. We have not found living specimens in the Willamette and lower Columbia R. in searches from 1988-1990. Still survives in the Fall R. and Pit R., Shasta Co., CA (1991); some possible specimens collected by USFWS near The Dalles, 1990. Apparently extinct in the upper Sacramento R. Also survives in the Okanogan R., Chelan Co., WA, and Curlew Lake, Ferry Co., WA. This species was likely heavily impacted by the BPA dams and impoundments; see comments under *Physella columbiana.*

**Criteria for Inclusion:** Riparian associate, current federal candidate; occurrence on public lands.

**Recommended status**: None currently. Should be Federal and State (CA, OR, and WA) Endangered.

**References**: Taylor (1981); Frest & Johannes, 1992; 1993a, 1993b; Deixis Consultants, 1988-1992.

***Anodonta wahlametensis*** **Lea, 1838** we suggest Willamette floater

**Type locality**: Near the mouth of the Willamette R., Multnomah Co., OR.

**Ecology**: "Lakes and slow rivers" (Taylor, 1981, p. 142), generally on soft substrates (mud-sand), but also on gravel, in fairly large streams and lakes only, in relatively slow current. A low elevation species.

**Original distribution**: Lower Willamette R., and lower Columbia R. in OR and WA from The Dalles to the mouth. In larger slow streams of northern CA as far south as the northern San Joaquin Valley. The former range includes Wahkiakum, Cowlitz, Clark, Skamania, and Klickitat cos., WA; Clatsop, Columbia, Multnomah, Clackamas, Marion, Hood River, and Wasco cos., OR; and Siskiyou, Shasta, Lassen, Modoc, Tehama, Glenn, Butte, Yuba, Sutter, Yolo, and Sacramento cos., CA.

**Current distribution**: Taylor (1981) reports that this species is probably eradicated over much of its original range. We have not found living specimens in the Willamette and lower Columbia R. in searches from 1988-1990. Still survives in the Fall R., CA (1991); one possible specimen collected by USFWS near The Dalles, 1990. Appears to be extinct in the upper Sacramento R. and almost certainly in the lower Sacramento as well. The lower Columbia populations were likely essentially extirpated by the construction and continued operation of the BPA dams and impoundments; see further comments under *Physella columbiana.* Could survive locally in deep pools with oxygenated substrate.

**Criteria for Inclusion:** Local endemic; possible occurrence on public lands; riparian associate.

**Recommended status**: None currently. Should be Federal and State (CA, OR, and WA) Endangered.

**References**: Taylor (1981); Deixis Consultants, 1988-1992.

***Pisidium (Cyclocalyx) ultramontanum*** **Prime, 1865** montane peaclam

**Type locality**: "Canoe Creek (now Hat Creek), probably at Rising River, Shasta County, California" (Taylor, 1981, p. 146).

**Ecology**: Generally found on sand-gravel substrate in spring-influenced streams and lakes; characteristically in areas with high mollusc diversity. Associates often include other Species of Special Concern, such as *Lanx klamathensis*, *Helisoma newberryi*, *Pyrgulopsis archimedis*, *Fluminicola* n. sp. 1, and *Lyogyrus* spp.

**Original distribution**: Periphery of the Great Basin in OR to Klamath R. and Pit R., OR-CA, as well as some of the larger lakes (Upper Klamath Lake, Tule Lake, Eagle Lake, possibly Lower Klamath Lake), Klamath Co., OR and Siskiyou, Lassen, and Modoc cos., CA.

**Current distribution**: Some populations are extinct. Known to survive in the Upper Klamath Lake area (including sites in Winema National Forest and Upper Klamath National Wildlife Refuge), the middle Pit R., and at Eagle Lake (Lassen National Forest). Sites may exist in Shasta National Forest also, although old sites there appear to be extinct.

**Criteria for inclusion:** Local endemic; federal listing candidate; occurrence on public lands; riparian associate.

**Recommended status**: Currently a C2 candidate. Should be considered Endangered in CA, OR, and federally.

**References**: Taylor (1981, 1985); Deixis Consultants, 1991-92.

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TABLE 1. MOLLUSC SPECIES OF SPECIAL CONCERN AND THEIR OCCURRENCES ON FEDERAL LANDS AND/OR PROPOSED DCAs. (cont.)

| Species and Common Name | Occurrences on Federal Lands | Relationship to Proposed DCAs |
|---|---|---|
| **LAND SNAILS** | | |
| *Ancotrema voyanum* (Newcomb, 1865)<br>hooded lancetooth | Shasta & Trinity National Forests | On DCAs CD-46 & 51 |
| *Cryptomastix devia* (Gould, 1846)<br>Puget oregonian | Fort Lewis Military Reservation & Columbia River Gorge National Scenic Area | Near or on DCAs WD-1 & 45 |
| *Cryptomastix hendersoni* (Pilsbry, 1928)<br>Columbia oregonian | Columbia River Gorge National Scenic Area | |
| *Helminthoglypta (Helminthoglypta) arrosa monticola* Roth, 1982<br>mountain shoulderband | King Range National Conservation Area, BLM | Range within DCA CD-8 |
| *Helminthoglypta (Helminthoglypta) hertleini* Hanna & Smith, 1937<br>Oregon shoulderband | In or near BLM land (Medford District); likely in Rogue River National Forest | |
| *Helminthoglypta (Helminthoglypta) intercessa* Roth, 1987<br>intermediate shoulderband | | |
| *Helminthoglypta (Helminthoglypta) talmadgei* Roth, 1988<br>Klamath shoulderband | Hoopa Valley Indian Reservation; Trinity & Six Rivers National Forests | On DCAs CD-35, 46, & 51 |
| *Megomphix californicus* Smith, 1960<br>California megomphix | Shasta & Trinity National Forests; possibly areas administered by Lassen National Forest | |
| *Megomphix hemphilli* (Binney, 1879)<br>Oregon megomphix | Mt. Baker & Olympic National Forests, Olympic National Park | |
| *Monadenia (Monadenia) callipeplus* Berry, 1940<br>(no common name) | Klamath National Forest | |
| *Monadenia (Monadenia) cristulata* Berry, 1940<br>small-crested sideband | Marble Mtn. Wilderness, Klamath National Forest | In or very close to DCA CD-33 |
| *Monadenia (Monadenia) fidelis celeuthia* Berry, 1937<br>traveling sideband | Rogue River National Forest | Near but not within DCA OD-19 |
| *Monadenia (Monadenia) fidelis flava* (Hemphill, 1892)<br>green sideband | Siskiyou National Forest; Rogue National Wild & Scenic River | |
| *Monadenia (Monadenia) fidelis klamathica* Berry, 1937<br>(no common name) | Klamath National Forest | Range is near but not within DCA CD-33 |
| *Monadenia (Monadenia) fidelis leonina* Berry, 1937<br>tawny sideband | Klamath National Forest | Opposite side of Klamath R. from DCA CD-32 |
| *Monadenia (Monadenia) fidelis minor* (Binney, 1885)<br>Dalles sideband | Columbia River Gorge National Scenic Area | |

TABLE 1. MOLLUSC SPECIES OF SPECIAL CONCERN AND THEIR OCCURRENCES ON FEDERAL LANDS AND/OR PROPOSED DCAs. (cont.)

| Species and Common Name | Occurrences on Federal Lands | Relationship to Proposed DCAs |
|---|---|---|
| **LAND SNAILS** (cont.) | | |
| *Monadenia (Monadenia) fidelis ochromphalus* Berry, 1937<br>yellow-base sideband | Klamath National Forest | |
| *Monadenia (Monadenia) fidelis pronotis* Berry 1931<br>rocky coast sideband | Near Redwood National Park & west border of Six Rivers National Forest | |
| *Monadenia (Monadenia) fidelis salmonensis* Talmadge, 1954<br>Salmon River sideband | Klamath National Forest | In DCA CD-33 |
| *Monadenia (Monadenia) rotifer* Berry, 1940<br>wheel sideband | Klamath National Forest | |
| *Monadenia (Monadenia) scottiana* Berry, 1940<br>Scott River sideband | Klamath National Forest | |
| *Monadenia (Monadenia) setosa* Talmadge, 1952<br>Trinity bristlesnail | Trinity National Forest | |
| *Monadenia (Shastelix) chaceana* (Berry, 1940)<br>Chace sideband | BLM | |
| *Monadenia (Shastelix) churchi* Hanna & Smith, 1933<br>Klamath sideband | Whiskeytown-Shasta-Trinity National Recreation Area, areas administered by Lassen National Forest, & Shasta & Trinity National Forests | |
| *Monadenia (Shastelix) troglodytes troglodytes* Hanna & Smith, 1933<br>Shasta sideband | Shasta National Forest & Whiskeytown-Shasta-Trinity National Recreation Area | |
| *Monadenia (Shastelix) troglodytes wintu* Roth, 1981<br>Wintu sideband | Shasta National Forest & Whiskeytown-Shasta-Trinity National Recreation Area | |
| *Oreohelix* n. sp. 1<br>Chelan mountainsnail | Wenatchee National Forest | Should be in DCA WD-31 |
| *Pristiloma arcticum crateris* Pilsbry, 1946<br>Crater Lake tightcoil | Crater Lake National Park; possibly Umpqua & Winema National Forests | Possibly DCA OD-20 |
| *Pristiloma pilsbryi* Vanatta, 1899<br>crowned tightcoil | | |
| *Punctum (Toltecia) hannai* Roth, 1985<br>Hanna spot | Trinity National Forest | |
| *Trilobopsis roperi* (Pilsbry, 1889)<br>Shasta chaparral | Shasta National Forest & Whiskeytown-Shasta-Trinity National Recreation Area | |
| *Trilobopsis tehamana* (Pilsbry, 1928)<br>Tehama chaperral | Shasta National Forest & BLM | |

TABLE 1. MOLLUSC SPECIES OF SPECIAL CONCERN AND THEIR OCCURRENCES ON FEDERAL LANDS AND/OR PROPOSED DCAs. (cont.)

| Species and Common Name | Occurrences on Federal Lands | Relationship to Proposed DCAs |
|---|---|---|
| **LAND SNAILS** (cont.) | | |
| *Vertigo* n. sp. 1<br>Hoko vertigo | Possibly Olympic National Forest & Olympic National Park | Near DCA WD-49 |
| *Vespericola depressa* (Pilsbry & Henderson, 1936)<br>Dalles hesperian | Mt. Hood National Forest, Columbia River Gorge National Scenic Area; possibly Gifford Pinchot National Forest | |
| *Vespericola eritrichius* (Berry, 1939)<br>(no common name) | | |
| *Vespericola euthales* (Berry, 1939)<br>large hesperian | | |
| *Vespericola karokorum* Talmadge, 1962<br>Karok hesperian | Six Rivers National Forest | |
| *Vespericola marinensis* Roth & Miller, 1993<br>Marin hesperian | Point Reyes National Seashore | Major part of range within DCA CD-28 |
| *Vespericola* n. sp. 1<br>Sasquatch hesperian | Klamath National Forest | |
| *Vespericola* n. sp. 2<br>Reeves Bar hesperian | | |
| *Vespericola* n. sp. 3<br>Klamath hesperian | Hoopa Valley Indian Reservation & Six Rivers National Forest | |
| *Vespericola pressleyi* Roth, 1985<br>Pressley hesperian | Trinity National Forest | |
| *Vespericola shasta* (Berry,1921)<br>Shasta hesperian | Shasta & Trinity National Forests; probably lands administered by Lassen National Forest. | Near the border of DCA CD-49; possibly CD-82 |
| *Vespericola sierranus* (Berry, 1921)<br>Siskiyou hesperian | Shasta & Rogue River National Forests & BLM (Medford District) | |
| **SLUGS** | | |
| *Deroceras hesperium* Pilsbry, 1944<br>evening fieldslug | Olympic National Park | |
| *Hemphillia burringtoni* (Pilsbry, 1948)<br>Burrington jumping-slug | Olympic National Park | Near DCA WD-47; one site in DCA WD-51 |
| *Hemphillia glandulosa* (Binney & Binney, 1872)<br>warty jumping-slug | Olympic National Park & Olympic National Forest | |

TABLE 1. MOLLUSC SPECIES OF SPECIAL CONCERN AND THEIR OCCURRENCES ON FEDERAL LANDS AND/OR PROPOSED DCAs. (cont.)

| Species and Common Name | Occurrences on Federal Lands | Relationship to Proposed DCAs |
|---|---|---|
| **SLUGS** (cont.) | | |
| *Hemphillia malonei* Pilsbry, 1917<br>Malone jumping-slug | Mt. Hood National Forest & Columbia River Gorge National Scenic Area | Near DCA OD-1 & OD-2 |
| *Hemphillia pantherina* Branson, 1975<br>panther jumping-slug | Gifford Pinchot National Forest | Near DCA WD-3 |
| *Prophysaon coeruleum* Cockerell, 1890<br>blue-gray tail-dropper | | |
| *Prophysaon dubium* Cockerell, 1890<br>Papillose tail-dropper | Trinity National Forest; probably Mt. Hood National Forest | |
| **FRESHWATER SNAILS** | | |
| *Fisherola nuttalli nuttalli* (Haldeman, 1841)<br>shortface lanx | Hanford Site (DOE), Deschutes Wild & Scenic River, Hells Canyon National Recreation Area, Okanogan National Forest, & Bonneville Power Administration | |
| *Fluminicola columbiana* Hemphill, in Pilsbry, 1899<br>Columbia pebblesnail | Hanford Site (DOE), Deschutes Wild & Scenic River, Hells Canyon National Recreation Area, Okanogan National Forest, & Bonneville Power Administration | |
| *Fluminicola* n. sp. 1<br>Klamath pebblesnail | Winema & Rogue River National Forests & Upper Klamath Lake National Wiildlife Refuge | In DCA OD-58 |
| *Fluminicola* n. sp. 2<br>tall pebblesnail | Near to Winema National Forest & Upper Klamath Lake National Wiildlife Refuge | Adjacent to DCA OD-58 |
| *Fluminicola* n. sp. 3<br>Klamath Rim pebblesnail | BLM (Medford District) | On lands included in LS/OG1 category |
| *Fluminicola* n. sp. 4<br>nerite pebblesnail | BLM (Medford District) | Within a few miles of & possibly in DCA OD-22 |
| *Fluminicola* n. sp. 5<br>toothed pebblesnail | BLM (Medford District) | Near DCA OD-22 |
| *Fluminicola* n. sp. 6<br>diminutive pebblesnail | BLM (Medford District) | Few miles E. of, & possibly occurs in, DCA OD-22 |
| *Fluminicola* n. sp. 7<br>topaz pebblesnail | BLM (Medford District) | East of DCA OD-22 |
| *Fluminicola* n. sp. 8<br>Fall Creek pebblesnail | BLM (Medford District) | Near, or possibly in, DCA OD-22 |

TABLE 1. MOLLUSC SPECIES OF SPECIAL CONCERN AND THEIR OCCURRENCES ON FEDERAL LANDS AND/OR PROPOSED DCAs. (cont.)

| Species and Common Name | Occurrences on Federal Lands | Relationship to Proposed DCAs |
|---|---|---|
| **FRESHWATER SNAILS** (cont.) | | |
| *Fluminicola* n. sp. 9<br>lunate pebblesnail | BLM (Medford District) | Few miles E. of DCA OD-22 |
| *Fluminicola* n. sp. 10<br>Keene Creek pebblesnail | BLM (Medford District) | In DCA OD-22 |
| *Fluminicola* n. sp. 11<br>Fredenburg pebblesnail | BLM (Medford District) | In DCA OD-22 |
| *Fluminicola* n. sp. 12<br>Umpqua pebblesnail | Umpqua National Forest | In DCA OD-19 |
| *Fluminicola* n. sp. 13<br>Sacramento pebblesnail | Shasta National Forest | Near DCAs CD-64, 65, 66, 67, & 68 |
| *Fluminicola* n. sp. 14<br>Potem pebblesnail | Possibly Shasta National Forest | Near DCAs CD-64, 65, 66, 67, & 68; close to CD-83 |
| *Fluminicola* n. sp. 15<br>flat-top pebblesnail | Could be in lands administered by Lassen National Forest & possibly Shasta & Trinity National Forests | Near DCAs CD-64, 65, 66, 67, & 68 |
| *Fluminicola* n. sp. 16<br>Shasta pebblesnail | Shasta National Forest | Near DCAs CD-64, 65, 66, 67, & 68 |
| *Fluminicola* n. sp. 17<br>disjunct pebblesnail | Possibly Shasta National Forest | Near DCAs CD-64, 65, 66, 67, & 68 |
| *Fluminicola* n. sp. 18<br>globular pebblesnail | Shasta National Forest; possibly lands administered by Lassen National Forest. | In DCA CD-82; near DCAs CD-64, 65, 66, 67, 81, & 82 |
| *Fluminicola* n. sp. 19<br>umbilicate pebblesnail | Lassen National Forest | |
| *Fluminicola* n. sp. 20<br>Lost Creek pebblesnail | Lassen National Forest | |
| *Fluminicola seminalis* (Hinds, 1842)<br>nugget pebblesnail | BLM (Medford District), Shasta National Forest, & lands administered by Lassen National Forest | |
| *Helisoma (Carinifex) newberryi newberryi* (Lea, 1858)<br>Great Basin rams-horn | Winema & Lassen National Forests, Upper Klamath Lake National Wildlife Refuge; possibly BLM (Medford District) | In DCA OD-58 |
| *Juga (Calibasis) acutifilosa* (Stearns, 1890)<br>scalloped juga | Modoc & Lassen National Forests, BLM (Medford District) | Near DCA OD-22 |
| *Juga (Calibasis) occata* (Hinds, 1844)<br>topaz juga | Shasta National Forest; possibly lands administered by Lassen National Forest | In DCA CD-82 |

TABLE 1. MOLLUSC SPECIES OF SPECIAL CONCERN AND THEIR OCCURRENCES ON FEDERAL LANDS AND/OR PROPOSED DCAs. (cont.)

| Species and Common Name | Occurrences on Federal Lands | Relationship to Proposed DCAs |
|---|---|---|
| **FRESHWATER SNAILS** (cont.) | | |
| *Juga (Juga) hemphilli dallesensis* (Henderson, 1935)<br>Dalles juga | Mt. Hood & Gifford Pinchot National Forests, Columbia River Gorge National Scenic Area | In DCA OD-1 |
| *Juga (Juga) hemphilli hemphilli* (Henderson, 1935)<br>barren juga | Mt. Hood National Forest, Columbia River Gorge National Scenic Area; possibly in Gifford Pinchot National Forest | In DCA OD-1; near WD-1 |
| *Juga (Juga) hemphilli* n. subsp. 1<br>(no common name) | Columbia River Gorge National Scenic Area; possibly Mt. Hood & Gifford Pinchot National Forests | Near DCA OD-1 |
| *Juga (Juga)* n. sp. 1<br>brown juga | Mt. Hood National Forest, Columbia River Gorge National Scenic Area; possibly Gifford Pinchot National Forests | Possibly DCA OD-1 |
| *Juga (Juga)* n. sp. 3<br>tall juga | Mt. Hood National Forest, Columbia River Gorge National Scenic Area; possibly Gifford Pinchot National Forest | In DCA OD-1 |
| *Juga (Oreobasis) chacei* (Henderson, 1935)<br>Chace juga | Six Rivers National Forest | In DCA CD-1 & CR-1A; possibly CD-29, OD-26 |
| *Juga (Oreobasis)* n. sp. 1<br>(no common name) | Columbia River Gorge National Scenic Area & Gifford Pinchot National Forest | In or near DCA WD-1 |
| *Juga (Oreobasis)* n. sp. 2<br>(no common name) | Mt. Hood National Forest & Columbia River Gorge National Scenic Area | Possibly DCA OD-1 |
| *Juga (Oreobasis)* n. sp. 3<br>(no common name) | Possibly Shasta National Forest | Near DCAs CD-64, 65, 66, 67, & 68 |
| *Juga (Oreobasis) orickensis* (Henderson, 1935)<br>redwood juga | Siskiyou, Six Rivers, & Trinity National Forests; Redwood National Park | In DCAs OD-26, CD-1, 2, 29, 35, 45, 46, & 51 |
| *Lanx alta* (Tryon, 1865)<br>highcap lanx | Siskiyou, Rogue River, Winema, Klamath, Six Rivers, & Trinity National Forests; Rogue National Wild & Scenic River | In DCAs CD-32, 35, 51, & 62; near CD-30, 31, 33, & 46 |
| *Lanx klamathensis* Hannibal, 1912<br>scale lanx | Winema National Forest, Upper Klamath Lake National Wildlife Refuge; possibly Rogue River National Forest | In or near DCA OD-58 |
| *Lanx patelloides* (Lea, 1856)<br>kneecap lanx | Shasta National Forest & areas administered by Lassen National Forest | In DCA CD-82 |
| *Lanx subrotundata* (Tryon, 1865)<br>rotund lanx | Umpqua National Forest; BLM Coos Bay & Roseburg Districts | In DCAs OD-32, 34, 36, & 16 |
| *Lyogyrus* n. sp. 1<br>Columbia duskysnail | Mt. Hood & Gifford Pinchot National Forests, & Columbia River Gorge National Scenic Area | In DCA OD-1 |
| *Lyogyrus* n. sp. 2<br>Washington duskysnail | Wenatchee National Forest | |

| Species and Common Name | Occurrences on Federal Lands | Relationship to Proposed DCAs |
|---|---|---|
| **FRESHWATER SNAILS** (cont.) | | |
| *Lyogyrus* n. sp. 3<br>canary duskysnail | Possibly Shasta & Lassen National Forests, & BLM lands | |
| *Lyogyrus* n. sp. 4<br>Klamath duskysnail | Winema National Forest & Upper Klamath Lake National Wildlife Refuge | In or near DCA OD-58 |
| *Lyogyrus* n. sp. 5<br>nodose duskysnail | Winema National Forest | Possibly DCA OD-58 |
| *Lyogyrus* n. sp. 6<br>mare's egg duskysnail | Winema National Forest & possibly Upper Klamath Lake National Wildlife Refuge | Possibly DCA OD-58 |
| *Physella (Physella) columbiana* (Hemphill, 1890)<br>rotund physa | Bonneville Power Administration | |
| *Pyrgulopsis archimedis* Berry, 1947<br>Archimedes pryg | Winema National Forest & possibly Upper Klamath Lake National Wildlife Refuge | Near DCA OD-58 |
| *Pyrgulopsis intermedia* (Tryon, 1865)<br>Crooked Creek springsnail | Shasta National Forest & areas administered by Lassen National Forest | In DCA CD-82 |
| *Pyrgulopsis* n. sp. 1<br>lake pyrg | Winema National Forest | |
| *Vorticifex klamathensis klamathensis* (Baker, 1945)<br>Klamath rams-horn | Winema National Forest & possibly Upper Klamath Lake National Wildlife Refuge | |
| *Vorticifex klamathensis sinitsini* (Baker, 1945)<br>Sinitsin rams-horn | Possibly Winema National Forest | |
| *Vorticifex* n. sp. 1<br>knobby rams-horn | Possibly Shasta National Forest, BLM, & areas administered by Lassen National Forest | |
| *Vorticifex neritoides* (Hemphill, 1890)<br>nerite rams-horn | Bonneville Power Administration | |
| **FRESHWATER CLAMS** | | |
| *Anodonta californiensis* Lea, 1852<br>California floater | Bonneville Power Administration | |
| *Anodonta wahlametensis* Lea, 1838<br>Willamette floater | Bonneville Power Administration | |
| *Pisidium (Cyclocalyx) ultramontanum* Prime, 1865<br>montane peaclam | Winema & Lassen National Forests & Upper Klamath Lake National Wildlife Refuge | Near or in DCA OD-58 |

TABLE 2. MOLLUSC SPECIES OF SPECIAL CONCERN WITHIN THE RANGE OF THE NORTHERN SPOTTED OWL.

| Species | Current Status | | | | Recommended Status | | | | Old Forest Associate | Riparian Associate | Priority Species |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | State | | | | State | | | | | |
| | FED | WA | OR | CA | FED | WA | OR | CA | | | |
| **LAND SNAILS** | | | | | | | | | | | |
| *Ancotrema voyanum* (Newcomb, 1865) | | | | | E | | | E | X | X | X |
| *Cryptomastix devia* (Gould, 1846) | | | | | E | E | E | | X | X | X |
| *Cryptomastix hendersoni* (Pilsbry, 1928) | | | | | E | E | E | | | X | |
| *Helminthoglypta (Helminthoglypta) arrosa monticola* Roth, 1982 | | | | | E | | | E | X | | X |
| *Helminthoglypta (Helminthoglypta) hertleini* Hanna & Smith, 1937 | | | | | E | | E | E | | X | X |
| *Helminthoglypta (Helminthoglypta) intercessa* Roth, 1987 | | | | | E | | | E | X | X | X |
| *Helminthoglypta (Helminthoglypta) talmadgei* Roth, 1988 | | | | | T | | | T | X | X | X |
| *Megomphix californicus* Smith, 1960 | | | | | T | | | T | X | X | X |
| *Megomphix hemphilli* (Binney, 1879) | | SC | SC | | T | T | T | | X | X | X |
| *Monadenia (Monadenia) callipeplus* Berry, 1940 | | | | | E | | | E | X | X | X |
| *Monadenia (Monadenia) cristulata* Berry, 1940 | | | | | E | | | E | X | ? | X |
| *Monadenia (Monadenia) fidelis celeuthia* Berry, 1937 | | | SC | | E | | E | | X | X | X |
| *Monadenia (Monadenia) fidelis flava* (Hemphill, 1892) | | | SC | | E | | E | | | X | X |
| *Monadenia Monadenia) fidelis klamathica* Berry, 1937 | | | | | E | | | E | X | X | X |
| *Monadenia (Monadenia) fidelis leonina* Berry, 1937 | | | | | E | | | E | X | X | X |
| *Monadenia (Monadenia) fidelis minor* (Binney, 1885) | C2 | | | | E | E | E | | | | X |
| *Monadenia (Monadenia) fidelis ochromphalus* Berry, 1937 | | | | | E | | | E | X | X | X |
| *Monadenia (Monadenia) fidelis pronotis* Berry, 1931 | C2 | | | | E | | | E | | X | X |
| *Monadenia (Monadenia) fidelis salmonensis* Talmadge, 1954 | | | | | E | | | E | X | X | X |
| *Monadenia (Monadenia) rotifer* Berry, 1940 | | | | | E | | | E | X | ? | X |
| *Monadenia (Monadenia) scottiana* Berry, 1940 | | | | | E | | | E | X | ? | X |
| *Monadenia (Monadenia) setosa* Talmadge, 1952 | | | | T | E | | | E | X | X | X |
| *Monadenia (Shastelix) chaceana* (Berry, 1940) | | | | | E | | | E | X | X | X |
| *Monadenia (Shastelix) churchi* Hanna & Smith, 1933 | | | | | T | | | T | X | X | X |
| *Monadenia (Shastelix) troglodytes troglodytes* H. & S., 1933 | C2 | | | | E | | | E | X | X | X |
| *Monadenia (Shastelix) troglodytes wintu* Roth, 1981 | | | | | E | | | E | X | X | X |
| *Oreohelix* n. sp. 1 | | | | | E | E | | | X | | X |
| *Pristiloma arcticum crateris* Pilsbry, 1946 | | | | | E | | E | | X | X | X |

TABLE 2. MOLLUSC SPECIES OF SPECIAL CONCERN WITHIN THE RANGE OF THE NORTHERN SPOTTED OWL. (cont.)

| Species | Current Status | | | | Recommended Status | | | | Old Forest Associate | Riparian Associate | Priority Species |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | State | | | | State | | | | | |
| | FED | WA | OR | CA | FED | WA | OR | CA | | | |
| **LAND SNAILS** (cont.) | | | | | | | | | | | |
| *Pristiloma pilsbryi* Vanatta, 1899 | | | | | E | E | E | | X | X | X |
| *Punctum (Toltecia) hannai* Roth, 1985 | | | | | T | | | T | X | X | X |
| *Trilobopsis roperi* (Pilsbry, 1889) | | | | | E | | | E | X | X | X |
| *Trilobopsis tehamana* (Pilsbry, 1928) | | | | | E | | | E | X | X | X |
| *Vertigo* n. sp. 1 | | | | | E | E | | | X | X | X |
| *Vespericola depressa* (Pilsbry & Henderson, 1936) | | | | | E | E | E | | X | X | X |
| *Vespericola eritrichius* (Berry, 1939) | | | | | E | | | E | X | X | X |
| *Vespericola euthales* (Berry, 1939) | | | | | E | | | E | X | X | X |
| *Vespericola karokorum* Talmadge, 1962 | | | | | E | | | E | X | X | X |
| *Vespericola marinensis* Roth & Miller, 1993 | C2 | | | | T | | | T | X | X | X |
| *Vespericola* n. sp. 1 | | | | | E | | | E | X | X | X |
| *Vespericola* n. sp. 2 | | | | | E | | | E | X | X | X |
| *Vespericola* n. sp. 3 | | | | | E | | | E | X | X | X |
| *Vespericola pressleyi* Roth, 1985 | | | | | E | | | E | X | X | X |
| *Vespericola shasta* (Berry, 1921) | | | | | E | | | E | X | X | X |
| *Vespericola sierranus* (Berry, 1921) | | | | | E | | E | E | X | X | X |
| **SLUGS** | | | | | | | | | | | |
| *Deroceras hesperium* Pilsbry, 1944 | | | | | E | E | E | | X | X | X |
| *Hemphillia burringtoni* (Pilsbry, 1948) | | SC | | | T | T | | | X | X | X |
| *Hemphillia glandulosa* (Binney & Binney, 1872) | | SC | SC | | T | T | E | | X | X | X |
| *Hemphillia malonei* Pilsbry, 1917 | | | SC | | E | | E | | X | X | X |
| *Hemphillia pantherina* Branson, 1975 | | SC | | | E | E | | | X | X | X |
| *Prophysaon coeruleum* Cockerell, 1890 | | SC | SC | | E | E | E | | X | X | X |
| *Prophysaon dubium* Cockerell, 1890 | | SC | SC | | E | E | E | E | X | X | X |

TABLE 2. MOLLUSC SPECIES OF SPECIAL CONCERN WITHIN THE RANGE OF THE NORTHERN SPOTTED OWL. (cont.)

| Species | Current Status | | | | Recommended Status | | | | Old Forest Associate | Riparian Associate | Priority Species |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | State | | | | State | | | | | |
| | FED | WA | OR | CA | FED | WA | OR | CA | | | |
| **FRESHWATER SNAILS** | | | | | | | | | | | |
| *Fisherola nuttalli nuttalli* (Haldeman, 1841) | C3 | | | | T | T | T | | | X | X |
| *Fluminicola columbiana* Hemphill, in Pilsbry, 1899 | C2 | | | | E | E | E | | | X | X |
| *Fluminicola* n. sp. 1 | | | | | E | | E | E | | X | X |
| *Fluminicola* n. sp. 2 | | | | | E | | E | | | X | X |
| *Fluminicola* n. sp. 3 | | | | | E | | E | | | X | X |
| *Fluminicola* n. sp. 4 | | | | | E | | E | | | X | X |
| *Fluminicola* n. sp. 5 | | | | | E | | E | | | X | X |
| *Fluminicola* n. sp. 6 | | | | | E | | E | | | X | X |
| *Fluminicola* n. sp. 7 | | | | | E | | E | | | X | X |
| *Fluminicola* n. sp. 8 | | | | | E | | E | | | X | X |
| *Fluminicola* n. sp. 9 | | | | | E | | E | | | X | X |
| *Fluminicola* n. sp. 10 | | | | | E | | E | | | X | X |
| *Fluminicola* n. sp. 11 | | | | | E | | E | | | X | X |
| *Fluminicola* n. sp. 12 | | | | | E | | E | | | X | X |
| *Fluminicola* n. sp. 13 | | | | | E | | | E | | X | X |
| *Fluminicola* n. sp. 14 | | | | | T | | | T | | X | X |
| *Fluminicola* n. sp. 15 | | | | | E | | | E | | X | X |
| *Fluminicola* n. sp. 16 | | | | | E | | | E | | X | X |
| *Fluminicola* n. sp. 17 | | | | | E | | | E | | X | X |
| *Fluminicola* n. sp. 18 | | | | | E | | | E | | X | X |
| *Fluminicola* n. sp. 19 | | | | | E | | | E | | X | X |
| *Fluminicola* n. sp. 20 | | | | | E | | | E | | X | X |
| *Fluminicola seminalis* (Hinds, 1842) | | | SC | | E | | E | E | X | X | X |
| *Helisoma (Carinifex) newberryi newberryi* (Lea, 1858) | | | SC | | E | | E | E | | X | |
| *Juga (Calibasis) acutifilosa* (Stearns, 1890) | | | | SC | T | | T | T | X | X | X |
| *Juga (Calibasis) occata* (Hinds, 1844) | | | | SC | E | | | E | X | X | X |
| *Juga (Juga) hemphilli dallesensis* (Henderson, 1935) | | SC | SC | | E | E | E | | X | X | X |
| *Juga (Juga) hemphilli hemphilli* (Henderson, 1935) | | SC | SC | | E | E | E | | X | X | X |

TABLE 2. MOLLUSC SPECIES OF SPECIAL CONCERN WITHIN THE RANGE OF THE NORTHERN SPOTTED OWL. (cont.)

| Species | Current Status | | | | Recommended Status | | | | Old Forest Associate | Riparian Associate | Priority Species |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | State | | | | State | | | | | |
| | FED | WA | OR | CA | FED | WA | OR | CA | | | |
| **FRESHWATER SNAILS** (cont.) | | | | | | | | | | | |
| *Juga (Juga) hemphilli* n. subsp. | | SC | SC | | E | E | E | | X | X | X |
| *Juga (Juga)* n. sp. 1 | | SC | SC | | E | E | E | | X | X | X |
| *Juga (Juga)* n. sp. 3 | | | | | E | | E | | X | X | X |
| *Juga (Oreobasis) chacei* (Henderson, 1935) | | | | | E | | | E | X | X | X |
| *Juga (Oreobasis)* n. sp. 1 | | SC | | | T | T | | | | X | X |
| *Juga (Oreobasis)* n. sp. 2 | | | SC | | T | | T | | | X | |
| *Juga (Oreobasis)* n. sp. 3 | | | | | E | | | E | | | X |
| *Juga (Oreobasis) orickensis* (Henderson, 1935) | | | | | T | | T | T | X | X | X |
| *Lanx alta* (Tryon, 1865) | | | SC | | ? | | T | T | X | X | X |
| *Lanx klamathensis* Hannibal, 1912 | | | | | E | | E | E | | X | X |
| *Lanx patelloides* (Lea, 1856) | | | SC | | T | | T | T | X | X | X |
| *Lanx subrotundata* (Tryon, 1865) | | | | | E | | E | | X | X | X |
| *Lyogyrus* n. sp. 1 | | SC | SC | | E | E | E | | X | X | X |
| *Lyogyrus* n. sp. 2 | | | | | E | E | | | | X | X |
| *Lyogyrus* n. sp. 3 | | | | | E | | | E | | X | X |
| *Lyogyrus* n. sp. 4 | | | | | E | | E | | | X | X |
| *Lyogyrus* n. sp. 5 | | | | | E | | E | | | X | X |
| *Lyogyrus* n. sp. 6 | | | | | E | E | E | | | X | X |
| *Physella (Physella) columbiana* (Hemphill, 1890) | | SC | SC | | E | E | E | | | X | X |
| *Pyrgulopsis archimedis* Berry, 1947 | | | | | E | | E | | | X | X |
| *Pyrgulopsis intermedia* (Tryon, 1865) | | | | | ? | | ? | E | | X | X |
| *Pyrgulopsis* n. sp. 1 | | | | | E | | | E | X | X | X |
| *Vorticifex klamathensis klamathensis* (Baker, 1945) | | | | | E | | E | | | X | X |
| *Vorticifex klamathensis sinitsini* (Baker, 1945) | | | | | E | | E | | | X | X |
| *Vorticifex* n. sp. 1 | | | | | E | | | E | | X | X |
| *Vorticifex neritoides* (Hemphill, 1890) | | SC | SC | | E | E | E | | | X | X |

TABLE 2. MOLLUSC SPECIES OF SPECIAL CONCERN WITHIN THE RANGE OF THE NORTHERN SPOTTED OWL. (cont.)

| Species | Current Status | | | | Recommended Status | | | | Old Forest Associate | Riparian Associate | Priority Species |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | State | | | | State | | | | | |
| | FED | WA | OR | CA | FED | WA | OR | CA | | | |
| **FRESHWATER CLAMS** | | | | | | | | | | | |
| *Anodonta californiensis* Lea, 1852 | C2 | | | | T | T | T | T | | X | X |
| *Anodonta wahlametensis* Lea, 1838 | | | | | E | E | E | E | | X | X |
| *Pisidium (Cyclocalyx) ultramontanum* Prime, 1865 | C2 | | | | E | | E | E | | X | X |

Explanation:

C2= Category 2 Federal candidate for listing as Threatened or Endangered
C3= Category 3 Federal candidate
T= Threatened
E= Endangered
SC= Species of Concern

| Species | Option 1 | | | | | Option 2 | | | | | Option 3 | | | | | Option 4 | | | | | Option 5 | | | | | Option 6 | | | | | Option 7 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | H | MH | M | ML | L | H | MH | M | ML | L | H | MH | M | ML | L | H | MH | M | ML | L | H | MH | M | ML | L | H | MH | M | ML | L | H | MH | M | ML | L |

## LAND SNAILS

| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Ancotrema voyanum* | ▨ | | | | | | | ▨ | | | | ▨ | | | | ▨ | | | | | ▨ | | | | | | | ▨ | | | | | | ▨ | |
| *Cryptomastix devia* | ▨ | | | | | ▨ | | | | | | ▨ | | | | ▨ | | | | | ▨ | | | | | ▨ | | | | | | | | ▨ | |
| *Cryptomastix hendersoni* | | ▨ | | | | | | ▨ | | | | | ▨ | | | | ▨ | | | | | ▨ | | | | | | ▨ | | | | | | ▨ | |
| *Helminthoglypta (H.) arrosa monticola* | ▨ | | | | | | ▨ | | | | ▨ | | | | | ▨ | | | | | ▨ | | | | | | ▨ | | | | | ▨ | | | |
| *Helminthoglypta (H.) hertleini* | ▨ | | | | | | | ▨ | | | | ▨ | | | | ▨ | | | | | ▨ | | | | | | | ▨ | | | | | | ▨ | |
| *Helminthoglypta (H.) intercessa* | ▨ | | | | | | ▨ | | | | ▨ | | | | | ▨ | | | | | ▨ | | | | | | ▨ | | | | | | ▨ | | |
| *Helminthoglypta (H.) talmadgei* | ▨ | | | | | | ▨ | | | | ▨ | | | | | ▨ | | | | | ▨ | | | | | | ▨ | | | | | | | | ▨ |
| *Megomphix californicus* | ▨ | | | | | | | ▨ | | | | ▨ | | | | ▨ | | | | | ▨ | | | | | | | ▨ | | | | | | ▨ | |
| *Megomphix hemphilli* | | ▨ | | | | | | ▨ | | | | | ▨ | | | | ▨ | | | | | ▨ | | | | | | ▨ | | | | | | | ▨ |
| *Monadenia (Monadenia) callipeplus* | ▨ | | | | | | | ▨ | | | | ▨ | | | | ▨ | | | | | ▨ | | | | | | | ▨ | | | | | | ▨ | |
| *Monadenia (M.) cristulata* | ▨ | | | | | | | ▨ | | | | ▨ | | | | ▨ | | | | | ▨ | | | | | | | ▨ | | | | | | | ▨ |
| *Monadenia (M.) fidelis celeuthia* | ▨ | | | | | | | ▨ | | | | ▨ | | | | ▨ | | | | | ▨ | | | | | | | ▨ | | | | | | | ▨ |
| *Monadenia (M.) fidelis flava* | ▨ | | | | | ▨ | | | | | ▨ | | | | | ▨ | | | | | ▨ | | | | | ▨ | | | | | | | | ▨ | |
| *Monadenia (M.) fidelis klamathica* | ▨ | | | | | | | ▨ | | | | ▨ | | | | ▨ | | | | | ▨ | | | | | | | ▨ | | | | | | | ▨ |
| *Monadenia (M.) fidelis leonina* | ▨ | | | | | | | ▨ | | | | ▨ | | | | ▨ | | | | | ▨ | | | | | | | ▨ | | | | | | | ▨ |
| *Monadenia (M.) fidelis minor* | ▨ | | | | | | ▨ | | | | | ▨ | | | | ▨ | | | | | ▨ | | | | | | ▨ | | | | | | | | ▨ |
| *Monadenia (M.) fidelis ochromphalus* | ▨ | | | | | | | ▨ | | | | ▨ | | | | ▨ | | | | | ▨ | | | | | | | ▨ | | | | | | | ▨ |
| *Monadenia (M.) fidelis pronotis* | ▨ | | | | | | | ▨ | | | | | ▨ | | | ▨ | | | | | ▨ | | | | | | | ▨ | | | | | | ▨ | |
| *Monadenia (M.) fidelis salmonensis* | ▨ | | | | | | | ▨ | | | | ▨ | | | | ▨ | | | | | ▨ | | | | | | | ▨ | | | | | | ▨ | |
| *Monadenia (M.) rotifer* | ▨ | | | | | | | ▨ | | | | ▨ | | | | ▨ | | | | | ▨ | | | | | | | ▨ | | | | | | | ▨ |
| *Monadenia (M.) scottiana* | ▨ | | | | | | | ▨ | | | | ▨ | | | | ▨ | | | | | ▨ | | | | | | | ▨ | | | | | | ▨ | |
| *Monadenia (M.) setosa* | ▨ | | | | | | | ▨ | | | ▨ | | | | | ▨ | | | | | ▨ | | | | | | | ▨ | | | | | | | ▨ |
| *Monadenia (Shastelix) chaceana* | ▨ | | | | | | ▨ | | | | ▨ | | | | | ▨ | | | | | ▨ | | | | | | ▨ | | | | | | | ▨ | |
| *Monadenia (S.) churchi* | ▨ | | | | | | ▨ | | | | ▨ | | | | | ▨ | | | | | ▨ | | | | | | ▨ | | | | | | | ▨ | |
| *Monadenia (S.) troglodytes troglodytes* | ▨ | | | | | | ▨ | | | | ▨ | | | | | ▨ | | | | | ▨ | | | | | | ▨ | | | | | | | ▨ | |
| *Monadenia (S.) troglodytes wintu* | ▨ | | | | | | ▨ | | | | ▨ | | | | | ▨ | | | | | ▨ | | | | | | ▨ | | | | | | | ▨ | |
| *Oreohelix n. sp. 1* | ▨ | | | | | | | ▨ | | | ▨ | | | | | ▨ | | | | | ▨ | | | | | | | ▨ | | | | | | | ▨ |
| *Pristiloma arcticum crateris* | ▨ | | | | | | ▨ | | | | | ▨ | | | | ▨ | | | | | ▨ | | | | | | ▨ | | | | | | | ▨ | |
| *Pristiloma pilsbryi* | ▨ | | | | | | ▨ | | | | | ▨ | | | | ▨ | | | | | ▨ | | | | | | ▨ | | | | | | | | ▨ |
| *Punctum (Toltecia) hannai* | ▨ | | | | | | ▨ | | | | ▨ | | | | | ▨ | | | | | ▨ | | | | | | ▨ | | | | | | ▨ | | |
| *Trilobopsis roperi* | | ▨ | | | | | | ▨ | | | | ▨ | | | | | ▨ | | | | | ▨ | | | | | | ▨ | | | | | | ▨ | |

## TABLE 3. MOLLUSC SPECIES AT RISK: VIABILITY RANKINGS UNDER VARIOUS MANAGEMENT OPTIONS. (cont.)

| Species | Option 1 | | | | | Option 2 | | | | | Option 3 | | | | | Option 4 | | | | | Option 5 | | | | | Option 6 | | | | | Option 7 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | H | MH | M | ML | L | H | MH | M | ML | L | H | MH | M | ML | L | H | MH | M | ML | L | H | MH | M | ML | L | H | MH | M | ML | L | H | MH | M | ML | L |
| **LAND SNAILS** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Trilobopsis tehamana* | | ▨ | | | | | | ▨ | | | | ▨ | | | | | ▨ | | | | | ▨ | | | | | | ▨ | | | | | | ▨ | |
| *Vertigo n. sp. 1* | ▨ | | | | | | ▨ | | | | ▨ | | | | | ▨ | | | | | ▨ | | | | | | ▨ | | | | | | ▨ | | |
| *Vespericola depressa* | ▨ | | | | | | ▨ | | | | ▨ | | | | | ▨ | | | | | ▨ | | | | | | ▨ | | | | | | | ▨ | |
| *Vespericola eritrichius* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Vespericola euthales* | ▨ | | | | | ▨ | | | | | ▨ | | | | | ▨ | | | | | ▨ | | | | | ▨ | | | | | | | ▨ | | |
| *Vespericola karokorum* | ▨ | | | | | | ▨ | | | | ▨ | | | | | ▨ | | | | | ▨ | | | | | | ▨ | | | | | | | | ▨ |
| *Vespericola marinensis* | ▨ | | | | | | ▨ | | | | ▨ | | | | | ▨ | | | | | ▨ | | | | | | ▨ | | | | | ▨ | | | |
| *Vespericola n. sp. 1* | ▨ | | | | | | | ▨ | | | | ▨ | | | | ▨ | | | | | ▨ | | | | | | | ▨ | | | | | ▨ | | |
| *Vespericola n. sp. 2* | ▨ | | | | | | | ▨ | | | | ▨ | | | | ▨ | | | | | ▨ | | | | | | | ▨ | | | | | ▨ | | |
| *Vespericola n. sp. 3* | ▨ | | | | | | ▨ | | | | ▨ | | | | | ▨ | | | | | ▨ | | | | | | ▨ | | | | | | ▨ | | |
| *Vespericola pressleyi* | ▨ | | | | | | | ▨ | | | | ▨ | | | | ▨ | | | | | ▨ | | | | | | | ▨ | | | | | | ▨ | |
| *Vespericola shasta* | ▨ | | | | | | | ▨ | | | | ▨ | | | | ▨ | | | | | ▨ | | | | | | | ▨ | | | | | | ▨ | |
| *Vespericola sierrana* | ▨ | | | | | | | ▨ | | | | ▨ | | | | ▨ | | | | | ▨ | | | | | | | ▨ | | | | | | ▨ | |
| **SLUGS** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Deroceras hesperium* | ▨ | | | | | | | ▨ | | | | ▨ | | | | ▨ | | | | | ▨ | | | | | | | ▨ | | | | | | ▨ | |
| *Hemphillia burringtoni* | ▨ | | | | | | | ▨ | | | | | ▨ | | | ▨ | | | | | ▨ | | | | | | | ▨ | | | | | | ▨ | |
| *Hemphillia glandulosa* | ▨ | | | | | | | ▨ | | | | | ▨ | | | ▨ | | | | | ▨ | | | | | | | ▨ | | | | | | ▨ | |
| *Hemphillia malonei* | ▨ | | | | | | | ▨ | | | | | ▨ | | | ▨ | | | | | ▨ | | | | | | | ▨ | | | | | | ▨ | |
| *Hemphillia pantherina* | ▨ | | | | | | | ▨ | | | | | ▨ | | | ▨ | | | | | ▨ | | | | | | | ▨ | | | | | | ▨ | |
| *Prophysaon coeruleum* | ▨ | | | | | | | ▨ | | | | | ▨ | | | ▨ | | | | | ▨ | | | | | | | ▨ | | | | | | ▨ | |
| *Prophysaon dubium* | ▨ | | | | | | | ▨ | | | | | ▨ | | | ▨ | | | | | ▨ | | | | | | | ▨ | | | | | | ▨ | |
| **FRESHWATER SNAILS** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Fisherola nuttalli nuttalli* | ▨ | | | | | | ▨ | | | | | | ▨ | | | ▨ | | | | | ▨ | | | | | | ▨ | | | | | | | | ▨ |
| *Fluminicola columbiana* | | | ▨ | | | | | | ▨ | | | | | ▨ | | | | ▨ | | | | | ▨ | | | | | | ▨ | | | | | | ▨ |
| *Fluminicola n. sp. 1* | ▨ | | | | | | | ▨ | | | | | ▨ | | | ▨ | | | | | ▨ | | | | | | | ▨ | | | | | | | ▨ |
| *Fluminicola n. sp. 2* | | | ▨ | | | | | | ▨ | | | | | | ▨ | | | ▨ | | | | | ▨ | | | | | | ▨ | | | | | | ▨ |
| *Fluminicola n. sp. 3* | ▨ | | | | | | | | | ▨ | | ▨ | | | | ▨ | | | | | ▨ | | | | | | | | | ▨ | | | | | ▨ |

## FRESHWATER SNAILS

| Species | Option 1 |  |  |  |  | Option 2 |  |  |  |  | Option 3 |  |  |  |  | Option 4 |  |  |  |  | Option 5 |  |  |  |  | Option 6 |  |  |  |  | Option 7 |  |  |  |  |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
|  | H | MH | M | ML | L | H | MH | M | ML | L | H | MH | M | ML | L | H | MH | M | ML | L | H | MH | M | ML | L | H | MH | M | ML | L | H | MH | M | ML | L |
| *Fluminicola n. sp. 4* | ▨ |  |  |  |  |  |  | ▨ |  |  |  | ▨ |  |  |  | ▨ |  |  |  |  | ▨ |  |  |  |  |  |  | ▨ |  |  |  |  |  |  | ▨ |
| *Fluminicola n. sp. 5* | ▨ |  |  |  |  |  |  | ▨ |  |  |  | ▨ |  |  |  | ▨ |  |  |  |  | ▨ |  |  |  |  |  |  | ▨ |  |  |  |  |  |  | ▨ |
| *Fluminicola n. sp. 6* | ▨ |  |  |  |  |  |  | ▨ |  |  |  | ▨ |  |  |  | ▨ |  |  |  |  | ▨ |  |  |  |  |  |  | ▨ |  |  |  |  |  |  | ▨ |
| *Fluminicola n. sp. 7* | ▨ |  |  |  |  |  |  | ▨ |  |  |  | ▨ |  |  |  | ▨ |  |  |  |  | ▨ |  |  |  |  |  |  | ▨ |  |  |  |  |  |  | ▨ |
| *Fluminicola n. sp. 8* | ▨ |  |  |  |  |  |  | ▨ |  |  |  | ▨ |  |  |  | ▨ |  |  |  |  | ▨ |  |  |  |  |  |  | ▨ |  |  |  |  |  |  | ▨ |
| *Fluminicola n. sp. 9* | ▨ |  |  |  |  |  |  | ▨ |  |  |  | ▨ |  |  |  | ▨ |  |  |  |  | ▨ |  |  |  |  |  |  | ▨ |  |  |  |  |  |  | ▨ |
| *Fluminicola n. sp. 10* | ▨ |  |  |  |  |  |  | ▨ |  |  |  | ▨ |  |  |  | ▨ |  |  |  |  | ▨ |  |  |  |  |  |  | ▨ |  |  |  |  |  |  | ▨ |
| *Fluminicola n. sp. 11* |  |  | ▨ |  |  |  |  |  |  | ▨ |  |  | ▨ |  |  |  |  | ▨ |  |  |  |  | ▨ |  |  |  |  |  |  | ▨ |  |  |  |  | ▨ |
| *Fluminicola n. sp. 12* | ▨ |  |  |  |  |  |  |  | ▨ |  | ▨ |  |  |  |  | ▨ |  |  |  |  | ▨ |  |  |  |  |  |  |  | ▨ |  |  |  |  |  | ▨ |
| *Fluminicola n. sp. 13* |  | ▨ |  |  |  |  |  |  |  | ▨ |  |  |  | ▨ |  |  | ▨ |  |  |  |  | ▨ |  |  |  |  |  |  |  | ▨ |  |  |  |  | ▨ |
| *Fluminicola n. sp. 14* |  | ▨ |  |  |  |  |  |  |  | ▨ |  | ▨ |  |  |  |  | ▨ |  |  |  |  | ▨ |  |  |  |  |  |  |  | ▨ |  |  |  |  | ▨ |
| *Fluminicola n. sp. 15* |  | ▨ |  |  |  |  |  |  |  | ▨ |  | ▨ |  |  |  |  | ▨ |  |  |  |  | ▨ |  |  |  |  |  |  |  | ▨ |  |  |  |  | ▨ |
| *Fluminicola n. sp. 16* |  |  | ▨ |  |  |  |  |  | ▨ |  |  |  | ▨ |  |  |  |  | ▨ |  |  |  |  | ▨ |  |  |  |  |  | ▨ |  |  |  |  |  | ▨ |
| *Fluminicola n. sp. 17* |  |  | ▨ |  |  |  |  |  | ▨ |  |  |  | ▨ |  |  |  |  | ▨ |  |  |  |  | ▨ |  |  |  |  |  | ▨ |  |  |  |  |  | ▨ |
| *Fluminicola n. sp. 18* |  | ▨ |  |  |  |  |  |  |  | ▨ |  | ▨ |  |  |  |  | ▨ |  |  |  |  | ▨ |  |  |  |  |  |  |  | ▨ |  |  |  |  | ▨ |
| *Fluminicola n. sp. 19* |  |  | ▨ |  |  |  |  |  |  | ▨ |  |  |  |  | ▨ |  |  | ▨ |  |  |  |  | ▨ |  |  |  |  |  |  | ▨ |  |  |  |  | ▨ |
| *Fluminicola n. sp. 20* |  |  | ▨ |  |  |  |  |  |  | ▨ |  |  |  |  | ▨ |  |  | ▨ |  |  |  |  | ▨ |  |  |  |  |  |  | ▨ |  |  |  |  | ▨ |
| *Fluminicola seminalis* |  | ▨ |  |  |  |  |  | ▨ |  |  |  |  | ▨ |  |  |  | ▨ |  |  |  |  | ▨ |  |  |  |  |  | ▨ |  |  |  |  |  |  | ▨ |
| *Helisoma (Carinifex) newberryi newberryi* | ▨ |  |  |  |  |  |  |  | ▨ |  |  |  | ▨ |  |  | ▨ |  |  |  |  | ▨ |  |  |  |  |  |  |  | ▨ |  |  |  |  |  | ▨ |
| *Juga (Calibasis) acutifilosa* |  | ▨ |  |  |  |  |  |  |  | ▨ |  |  |  |  | ▨ |  | ▨ |  |  |  |  | ▨ |  |  |  |  |  |  |  | ▨ |  |  |  |  | ▨ |
| *Juga (C.) occata* |  | ▨ |  |  |  |  |  |  |  | ▨ |  |  |  |  | ▨ |  | ▨ |  |  |  |  | ▨ |  |  |  |  |  |  |  | ▨ |  |  |  |  | ▨ |
| *Juga (Juga) hemphilli dallesensis* | ▨ |  |  |  |  |  |  |  | ▨ |  |  |  |  | ▨ |  | ▨ |  |  |  |  | ▨ |  |  |  |  |  |  |  | ▨ |  |  |  |  |  | ▨ |
| *Juga (J.) hemphilli hemphilli* | ▨ |  |  |  |  |  |  |  | ▨ |  |  |  |  | ▨ |  | ▨ |  |  |  |  | ▨ |  |  |  |  |  |  |  | ▨ |  |  |  |  |  | ▨ |
| *Juga (J.) hemphilli n. subsp. 1* | ▨ |  |  |  |  |  |  |  | ▨ |  |  |  |  | ▨ |  | ▨ |  |  |  |  | ▨ |  |  |  |  |  |  |  | ▨ |  |  |  |  |  | ▨ |
| *Juga (J.) n. sp. 1* | ▨ |  |  |  |  |  |  |  | ▨ |  |  |  |  | ▨ |  | ▨ |  |  |  |  | ▨ |  |  |  |  |  |  |  | ▨ |  |  |  |  |  | ▨ |
| *Juga (J.) n. sp. 3* | ▨ |  |  |  |  |  |  |  | ▨ |  |  |  |  | ▨ |  | ▨ |  |  |  |  | ▨ |  |  |  |  |  |  |  | ▨ |  |  |  |  |  | ▨ |
| *Juga (Oreobasis) chacei* | ▨ |  |  |  |  |  |  |  | ▨ |  |  |  |  | ▨ |  | ▨ |  |  |  |  | ▨ |  |  |  |  |  |  |  | ▨ |  |  |  |  | ▨ |  |
| *Juga (O.) n. sp. 1* | ▨ |  |  |  |  |  |  |  | ▨ |  |  |  |  | ▨ |  | ▨ |  |  |  |  | ▨ |  |  |  |  |  |  |  | ▨ |  |  |  |  |  | ▨ |
| *Juga (O.) n. sp. 2* | ▨ |  |  |  |  |  |  |  | ▨ |  |  |  |  | ▨ |  | ▨ |  |  |  |  | ▨ |  |  |  |  |  |  |  | ▨ |  |  |  |  |  | ▨ |
| *Juga (O.) n. sp. 3* |  |  | ▨ |  |  |  |  |  |  | ▨ |  |  |  |  | ▨ |  |  | ▨ |  |  |  |  | ▨ |  |  |  |  |  |  | ▨ |  |  |  |  | ▨ |
| *Juga (O.) orickensis* | ▨ |  |  |  |  |  |  |  | ▨ |  |  |  | ▨ |  |  | ▨ |  |  |  |  | ▨ |  |  |  |  |  |  |  | ▨ |  |  |  |  |  | ▨ |
| *Lanx alta* | ▨ |  |  |  |  |  |  |  | ▨ |  | ▨ |  |  |  |  | ▨ |  |  |  |  | ▨ |  |  |  |  |  |  |  | ▨ |  |  |  |  |  | ▨ |

TABLE 3. MOLLUSC SPECIES AT RISK: VIABILITY RANKINGS UNDER VARIOUS MANAGEMENT OPTIONS. (cont.)

**FRESHWATER SNAILS**

| | Option 1 | | | | | Option 2 | | | | | Option 3 | | | | | Option 4 | | | | | Option 5 | | | | | Option 6 | | | | | Option 7 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Species | H | MH | M | ML | L | H | MH | M | ML | L | H | MH | M | ML | L | H | MH | M | ML | L | H | MH | M | ML | L | H | MH | M | ML | L | H | MH | M | ML | L |
| *Lanx klamathensis* | ▨ | | | | | | | | ▨ | | | | | | ▨ | ▨ | | | | | ▨ | | | | | | | | ▨ | | | | | | ▨ |
| *Lanx patelloides* | ▨ | | | | | | | | ▨ | | | ▨ | | | | ▨ | | | | | ▨ | | | | | | | | ▨ | | | | | | ▨ |
| *Lanx subrotundata* | ▨ | | | | | | | ▨ | | | | ▨ | | | | ▨ | | | | | ▨ | | | | | | | ▨ | | | | | | | ▨ |
| *Lyogyrus n. sp. 1* | ▨ | | | | | | | ▨ | | | | | | ▨ | | ▨ | | | | | ▨ | | | | | | | ▨ | | | | | | | ▨ |
| *Lyogyrus n. sp. 2* | ▨ | | | | | | | ▨ | | | | | | ▨ | | ▨ | | | | | ▨ | | | | | | | ▨ | | | | | | | ▨ |
| *Lyogyrus n. sp. 3* | | | ▨ | | | | | | ▨ | | | | | | ▨ | | | ▨ | | | | | ▨ | | | | | | ▨ | | | | | | ▨ |
| *Lyogyrus n. sp. 4* | ▨ | | | | | | | | ▨ | | | | | | ▨ | ▨ | | | | | ▨ | | | | | | | | ▨ | | | | | | ▨ |
| *Lyogyrus n. sp. 5* | ▨ | | | | | | | ▨ | | | | | | | ▨ | ▨ | | | | | ▨ | | | | | | | ▨ | | | | | | | ▨ |
| *Lyogyrus n. sp. 6* | | | ▨ | | | | | | | ▨ | | | | | ▨ | | | ▨ | | | | | ▨ | | | | | | | ▨ | | | | | ▨ |
| *Physella (Physella) columbiana* | | | | ▨ | | | | | ▨ | | | | | ▨ | | | | | ▨ | | | | | ▨ | | | | | ▨ | | | | | | ▨ |
| *Pyrgulopsis archimedis* | | | ▨ | | | | | | ▨ | | | | | | ▨ | | | ▨ | | | | | ▨ | | | | | | ▨ | | | | | | ▨ |
| *Pyrgulopsis intermedia* | ▨ | | | | | | | | ▨ | | | | | | ▨ | ▨ | | | | | ▨ | | | | | | | | ▨ | | | | | | ▨ |
| *Pyrgulopsis n. sp. 1* | | | ▨ | | | | | | ▨ | | | | | | ▨ | | | ▨ | | | | | ▨ | | | | | | ▨ | | | | | | ▨ |
| *Vorticifex klamathensis klamathensis* | ▨ | | | | | | | | ▨ | | | | | | ▨ | ▨ | | | | | ▨ | | | | | | | | ▨ | | | | | | ▨ |
| *Vorticifex klamathensis sinitsini* | | | ▨ | | | | | | | ▨ | | | | | ▨ | | | ▨ | | | | | ▨ | | | | | | | ▨ | | | | | ▨ |
| *Vorticifex n. sp. 1* | | | ▨ | | | | | | | ▨ | | | | | ▨ | | | ▨ | | | | | ▨ | | | | | | | ▨ | | | | | ▨ |
| *Vorticifex neritoides* | | | | ▨ | | | | | ▨ | | | | | | | | | | ▨ | | | | | ▨ | | | | | ▨ | | | | | | ▨ |

**FRESHWATER CLAMS**

| | Option 1 | | | | | Option 2 | | | | | Option 3 | | | | | Option 4 | | | | | Option 5 | | | | | Option 6 | | | | | Option 7 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Species | H | MH | M | ML | L | H | MH | M | ML | L | H | MH | M | ML | L | H | MH | M | ML | L | H | MH | M | ML | L | H | MH | M | ML | L | H | MH | M | ML | L |
| *Anodonta californiensis* | ▨ | | | | | | | | ▨ | | | ▨ | | | | ▨ | | | | | ▨ | | | | | | | | | ▨ | | | | | ▨ |
| *Anodonta wahlametensis* | ▨ | | | | | | | | ▨ | | | | | ▨ | | ▨ | | | | | ▨ | | | | | | | | ▨ | | | | | | ▨ |
| *Pisidium (Cyclocalyx) ultramontanum* | ▨ | | | | | | | | ▨ | | | | | | ▨ | ▨ | | | | | ▨ | | | | | | | | ▨ | | | | | | ▨ |

Explanation:

Options 1-7: see text pp. 23-24 and references thereon.

Scale: see text p. 24:

H- High
MH- Medium High
M- Medium
ML- Medium Low
L- Low

Screened box is selected choice.

# MOLLUSC SPECIES OF SPECIAL CONCERN WITHIN THE RANGE OF THE NORTHERN SPOTTED OWL

## ADDENDUM

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June 13, 1993

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## ADDENDUM

# MOLLUSC SPECIES OF SPECIAL CONCERN WITHIN THE RANGE OF THE NORTHERN SPOTTED OWL

## INTRODUCTION

On April 21, 1993 a Mollusc Viability Panel, consisting of three members (Terrence Frest, Edward Johannes, and Barry Roth), convened in Portland, Oregon, at the behest of the Forest Ecosystem Management Working Group, to evaluate mollusc Species of Special Concern occurring within the range of the Northern Spotted Owl *Strix occidentalis caurina*. The working species list was derived from an earlier list compiled by Frest & Johannes (1991), supplemented later from information supplied by Barry Roth (1993) and by Frest & Johannes (1993a). This list of about 108 taxa represents a considerable expansion from the 57 in Frest & Johannes (1991); the smaller list also appears in the drafts of the Northern Spotted Owl Recovery Plan USFWS (1992a, b) and in the SAT report (Thomas *et al.*, 1993).

We were asked to evaluate the effects of seven proposed management options (described in Frest & Johannes, 1993a and references therein) using a five-category rating scale assessing viability prospects from highest to lowest probability (also described in Frest & Johannes, 1993a, and references therein). Roth submitted a draft version of his report, containing considerable background information and analysis, at the April 21 meeting. Roth submitted the final version of his report on April 27, 1993 (Roth, 1993). Frest & Johannes submitted a similar report, providing background species information and also re-evaluating the rankings of the April 21 meeting, on May 1, 1993.

Subsequently, the same panel was called back to assess another series of management options (APPENDIX 1 herein) using another viability rating scale (APPENDIX 2 herein). Neither the options or the scale were identical to the preceding set. The 108-taxon list was evaluated at a meeting in Portland, Oregon on June 3-4, 1993 (Roth was present on June 3; he is to complete his rankings on June 11, 1993 (we have not seen this material); Frest & Johannes were present June 3-4). For several days after the meeting, Frest & Johannes reviewed the June meeting rankings, background information and other relevant materials, notably including Roth (1993). This addendum represents a summary and revision of this material. We also took the opportunity to supplement and correct background data and tables in the May 1 report (Frest & Johannes, 1993a). The appendices and Table 2 of the ADDENDUM are reprinted directly from documents supplied to the viability panel by the Interagency Team.

## RESULTS

The panel provided rankings for a total of 104 taxa (Table 1). Two land snail species were not ranked, due to the possibility that they may not occur on federal lands. Two other land snail taxa were not ranked because the panel lacked sufficient information for a judgement; both are regarded as rare or endemic taxa likely occurring on federal lands, but not collected recently. Some difficulties were encountered in evaluating the second set of options:

1) In contrast to the earlier meeting, no background material was provided in advance.

2) Moreover, at the time of the meeting, some information was not available for some options (8 & 9: Table 2 and APPENDIX 1 herein).

3) Similarly, errors on, and omissions from, the maps sometimes hindered interpretation significantly.

4) In the last go-around, major proposed old growth reserves (termed designated conservation areas [DCAs] ?= late-successional reserves) were individually discriminated by number and easily located on the maps. These were incorporated into our tables and text (Table 1 is an example) to aid area managers in locating Species of Special Concern. Under the present options, individual tracts or reserves were not separately designated and were difficult to locate. It appears that certain tracts have either been deleted or have had their boundaries changed (no new ones appear to have been added). This may make it difficult to determine if a particular mollusc species is or is not in a late-successional reserve.

5) Given the complexity of the options and the nature of the rating scale, comparatively little time was available to complete the rankings.

6) The rating scale format may have inadvertently complicated the ratings. For land snails, the degree of disturbance to date is such that *for the formerly common and widespread species* a relatively small "percentage of the potential habitat sites remains occupied"; and proposed management does "create significant dispersal barriers that would isolate populations"; by the end of the 100-year period little improvement is reasonably to be expected for any except a couple of slug and snail species. It should be noted, however, that we did not rank any of the relatively common and widespread species. All species considered are ones that occupy a comparatively small part of the range of the Northern Spotted Owl and in nearly all cases should now be considered rare and endemic taxa.

It must be emphasized that a significant portion of the species in most plant and animal groups, in any regional biota, fall into the category of endemics or species with relatively small ranges. "The most pervasive feature of geographic distributions is that they are limited. No species is completely cosmopolitan, and most species and genera, and even many orders and families, are confined to restricted regions" (Brown & Gibson, 1983). Limited geographic range, even under natural conditions, is the norm for most species; with pervasive disturbance, even formerly widespread species will fall into this category. For such forms, taking into account the facts that 1) they often occupy scattered habitat patches; and 2) these patches occur only in a limited geographic area, the effects of management must be specified carefully for a given habitat and region. In general, all such taxa are more readily subject to extinction from major disturbance; but certain rare, endemic, and unique species, and their habitats, may fortuitously fall into areas exempt from management or disturbance, and hence will remain secure despite extensive regional disturbance. As a result, ratings for habitat- or geographically-restricted taxa should be highly individualized, as were ours here. Proposed management consideration of rare and locally endemic taxa, as described in APPENDIX 2, partially addresses the problem; but does not apply well to the common situation of species that are not free or rapid dispersers and are already absent from the bulk of their former range. These points have been addressed earlier (Frest & Johannes, 1993a, b); but another example may be instructive. Certain land snails may be able to disperse at the rate of several miles per year (Roth, *pers. comm.*, 1993); but this is clearly exceptional. As a contrast, we cite *Oreohelix haydeni corrugata* Henderson & Daniels, 1916, a Wasatch Mountains (Utah) taxon that has not expanded its range from its present location into some immediately adjacent suitable habitat available for the last 13, 000 years (Clarke & Hovingh, 1993).

A very significant portion of the total biodiversity in old growth forests is included in this category. For example, realistically most mollusc species within the range of the Northern Spotted Owl, regardless of their commonness or rarity, endemism or cosmopolitanism, now and for the foreseeable future exist "only in refugia" with the possibility of population interactions "severely restricted". Many other native Pacific Northwest plant and animal species likely are in the same condition. Given the environmental heterogeneity that is characteristic of the Pacific Northwest (Harris, 1984), it is to be expected that alpha, beta, and gamma diversity would all be high in the region. Though still incompletely known, biodiversity here is exceptional for a coniferous forest biome. The combined effects of physiography and geologic history are responsible; these influences have been described for the mollusc fauna by Frest & Johannes (1993a). Management approaches must accommodate that heterogeneity to be successful.

The former scale, which in effect attempted to assess the probability of extinction on an evenly divided continuum (see Frest & Johannes, 1993, p. 24), was perhaps conceptually more robust. In the present case, the possibility of extinction or extirpation seems restricted to outcome

D (see APPENDIX 2). Additionally, the rating scale for this set of options seems oriented toward a broad-scale or "regional assessment" of each and every taxon considered. We feel that the broad-brush management approach, economically attractive as it may be, is not appropriate or possible for many species. Indeed, it could be argued that just such broad prescriptions and understandings of forest health and management yielded the present situation.

For some (perhaps most) groups, the majority of taxa likely require individualized management or a detailed community ecology approach. Molluscs are one such group. Given the scale categories and definitions, we found it quite difficult in practice to find options that would "produce an 80% likelihood of achieving outcome A" and preclude the possibility of species extinction without mitigation. On the other hand, mitigation is eminently practical for most or all narrow endemics or habitat-restricted species. Successful maintenance should be possible for all mollusc species, for example, even in relatively small reserves, if these are properly located and secured. Examples of tract sizes for land snail colonies, *e.g.* are provided in Frest (1984, 1991); Frest & Johannes (1993b) and Roth & Pressley (1986). Surveys for molluscs are relatively easy to conduct. Examples are numerous: some recent ones are referenced in Frest (1991); Frest & Dickson, 1986; Roth & Eng (1980); Roth (unpublished); Neitzel & Frest (1993); Frest & Johannes (1993b); Clarke & Hovingh (1993).

7) There are also some minor problems with evaluation of "other influences on viability" (APPENDIX 2). For example, the statement that "some species occur largely on nonfederal lands within the range of the spotted owl, so federal land management will not be the major determinant of their viability" is dubious. To assent, it is necessary to assume that populations occurring on nonfederal lands will be managed in such a manner as to survive; it is equally or more reasonable to assume that populations on nonfederal lands in the main will not be protected. Hence, federal populations may be very significant to survival of species occurring elsewhere. If one accepted the worst-case assessment, namely that populations occurring off federal lands may be effectively written off, then such species may actually be more at risk than those occurring entirely on federal lands.

The statement that "some species occur in ranges that only partly overlap the spotted owl's range, so management within the range of the owl is not the major determinant of their viability" has similar problems. What is assumed is that the non-owl part of the range is secure: this could be true for some taxa, but certainly is not for many. Again, the outcome of protection on federal lands and no or lesser protection elsewhere should be considered. The mentioned statements seemed intended to cover the situation of certain bird species, such as the marbled murrelet, whose life cycle only partly is affected by factors operative on federal forest lands. As written , however, they have more general implications.

# DISCUSSION

Taking the options, ranking scale, and supporting materials as a whole, it sometimes seemed as if they were more noticeably oriented toward the preservation of the two Threatened bird species than were the preceding set of options. One wonders if the principles of ecosystem management, featured prominently even if unevenly applied in Thomas *et al.* (1993), USFWS (1992a, b), and the first set of management options, are less relevant to these options.

One other point of Frest & Johannes (1993a) should be reiterated here. Our rankings have been made in both cases under the explicit assumption that proposed management options will be fully implemented. We have previously noted that this would require considerable human and fiscal resources over and above what is now available to the agencies involved. Moreover, we have noted the lack of biotic inventories on many federal tracts; paucity of agency personnel knowledgeable about such groups as invertebrates; and a general lack of concern about taxa other than Three F species. The fact that planned wildlife protection and enhancement objectives are often not achieved (*e.g.* GAO, 1989) is significant here too. A major revamping of agency goals and orientation will be required to carry out the proposals. They are feasible; and appropriately trained and knowledgeable personnel are available. But this was also the case with the last full-scale effort to design and implement old-growth reserves (Harris, 1984).

It should be clear from Table 1 that Option 1 was in general preferable for most land as well as freshwater taxa. In general, the most restrictive management option, applied as broadly as possible, seemed appropriate for species protection. The principle here was that no exploitation at all of large areas in each major habitat was necessary to guard against the possibility of extinction. Some contend that the no-management approach is difficult to apply across the board, due to effects of past management practices. For example, fire suppression in old-growth stands east of the crest of the Cascades may have left them, and forest floor taxa such as molluscs associated with them, more vulnerable to catastrophic fires. It may be that thinning such stands is justified (for effects of fires on land snails in one National Forest, see Frest & Johannes, 1993b). However, thinning could perhaps also be as destructive as clear-cuts, depending on the precise methodology employed, and should be considered only if supported by careful study. The irony of applying another form of management to correct the effects of earlier attempts is considerable, and such proposals should be viewed with considerable skepticism. Also, the biota of the east-side Cascades is more poorly known than that of the west, but is significantly different. Land snails, for example belong to different biotic provinces (Frest & Johannes, 1993a, Figure 1).

As before, those options with strong riparian protections were regarded more highly for both land snails and for aquatic molluscs; the reasoning has been stated previously (Frest & Johannes, 1993). Larger buffer widths (this time idiosyncratically described in terms of "site-potential tree height") were favored, as were those alternatives allowing full SAT provisions. As noted above, it was somewhat difficult to evaluate Options 8 & 9 on an equal footing with the rest because of incomplete information. Certain alternatives explicitly did not consider protection of SAT species (Options 7 and 8). Even though the SAT list (Thomas *et al.*, 1993) obviously should be updated and expanded, for example to include all species covered by the various viability panels, those options guaranteeing consideration of at least some SAT species seem preferable.

One factor involving all options was the acreage of so-called matrix forest. Whether the number of green trees left standing was 2 or 6 per acre the effect would be extirpation of most land and freshwater molluscs, as well as many other plant and animal species. The number of downed logs per acre was similarly so small as to be irrelevant in comparison to raw acreage so treated. In the case of late-successional reserves, details of management are significant as well as acreage. For all options except 1, some "timber harvest" will be allowed, to varying degrees.

Despite the caveats and reservations stated above, the overall rankings of these options are relatively robust, in our opinion. It is interesting to note that the results roughly parallel those from the first set of options. One option (1) is definitely superior; one (option 7) is definitely inferior. Of the remaining options, 3, 5, 8, & 9 seemed inferior to varying degrees. Option 4 seemed generally acceptable for many species.

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TABLE 1. MOLLUSC SPECIES AT RISK: VIABILITY RANKINGS UNDER VARIOUS MANAGEMENT OPTIONS.

## LAND SNAILS

| Species | Not Rated | Option 1 | | | | Option 3 | | | | Option 4 | | | | Option 5 | | | | Option 7 | | | | Option 8 | | | | Option 9 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | A | B | C | D | A | B | C | D | A | B | C | D | A | B | C | D | A | B | C | D | A | B | C | D | A | B | C | D |
| *Ancotrema voyanum* | | 70 | 10 | 20 | 0 | 10 | 10 | 50 | 30 | 0 | 30 | 40 | 30 | 0 | 20 | 40 | 40 | 0 | 10 | 20 | 70 | 0 | 10 | 20 | 70 | 0 | 10 | 20 | 70 |
| *Cryptomastix devia* | | 50 | 20 | 20 | 10 | 40 | 20 | 20 | 20 | 40 | 30 | 20 | 10 | 0 | 10 | 50 | 40 | 0 | 20 | 30 | 50 | 0 | 20 | 40 | 40 | 0 | 10 | 40 | 50 |
| *Cryptomastix hendersoni* | | 60 | 30 | 10 | 0 | 50 | 30 | 10 | 10 | 30 | 30 | 30 | 10 | 30 | 30 | 30 | 10 | 30 | 30 | 20 | 20 | 30 | 30 | 20 | 20 | 30 | 30 | 20 | 20 |
| *Helminthoglypta (H.) arrosa monticola* | | 70 | 20 | 10 | 0 | 50 | 30 | 10 | 10 | 60 | 20 | 10 | 0 | 40 | 30 | 20 | 10 | 50 | 30 | 10 | 10 | 50 | 30 | 10 | 10 | 40 | 30 | 20 | 10 |
| *Helminthoglypta (H.) hertleini* | | 70 | 10 | 10 | 10 | 40 | 30 | 20 | 10 | 40 | 30 | 20 | 10 | 40 | 30 | 20 | 10 | 20 | 30 | 30 | 20 | 20 | 30 | 30 | 20 | 25 | 25 | 35 | 15 |
| *Helminthoglypta (H.) intercessa* | * | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Helminthoglypta (H.) talmadgei* | | 60 | 20 | 20 | 0 | 40 | 30 | 20 | 10 | 30 | 30 | 20 | 20 | 30 | 30 | 20 | 20 | 30 | 30 | 20 | 30 | 30 | 30 | 20 | 20 | 30 | 30 | 20 | 20 |
| *Megomphix californicus* | | 70 | 20 | 10 | 0 | 60 | 20 | 10 | 10 | 60 | 20 | 10 | 10 | 30 | 30 | 20 | 20 | 30 | 20 | 20 | 30 | 20 | 20 | 30 | 30 | 20 | 20 | 30 | 30 |
| *Megomphix hemphilli* | | 70 | 20 | 10 | 0 | 50 | 30 | 10 | 10 | 60 | 20 | 20 | 0 | 30 | 30 | 20 | 20 | 20 | 30 | 30 | 20 | 30 | 20 | 30 | 20 | 30 | 30 | 20 | 20 |
| *Monadenia (Monadenia) callipeplus* | | 60 | 20 | 10 | 10 | 20 | 40 | 20 | 20 | 40 | 20 | 20 | 20 | 20 | 30 | 20 | 30 | 10 | 20 | 30 | 40 | 20 | 20 | 20 | 40 | 20 | 20 | 20 | 40 |
| *Monadenia (M.) cristulata* | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Monadenia (M.) fidelis celeuthia* | | 60 | 30 | 10 | 0 | 40 | 30 | 20 | 10 | 30 | 30 | 30 | 10 | 30 | 30 | 20 | 20 | 20 | 30 | 20 | 30 | 30 | 30 | 20 | 20 | 30 | 30 | 20 | 20 |
| *Monadenia (M.) fidelis flava* | | 70 | 20 | 10 | 0 | 60 | 20 | 20 | 0 | 60 | 30 | 10 | 0 | 40 | 30 | 30 | 0 | 30 | 40 | 20 | 10 | 30 | 30 | 40 | 0 | 30 | 30 | 30 | 10 |
| *Monadenia (M.) fidelis klamathica* | | 70 | 10 | 20 | 0 | 50 | 20 | 20 | 10 | 50 | 30 | 20 | 0 | 40 | 30 | 20 | 10 | 30 | 10 | 40 | 20 | 30 | 20 | 30 | 20 | 20 | 30 | 40 | 10 |
| *Monadenia (M.) fidelis leonina* | | 40 | 20 | 20 | 20 | 30 | 20 | 30 | 20 | 40 | 20 | 20 | 20 | 30 | 30 | 20 | 20 | 30 | 20 | 20 | 30 | 30 | 30 | 20 | 20 | 30 | 30 | 20 | 20 |
| *Monadenia (M.) fidelis minor* | | 70 | 20 | 10 | 0 | 50 | 30 | 20 | 0 | 40 | 30 | 30 | 0 | 40 | 30 | 30 | 0 | 30 | 30 | 20 | 20 | 40 | 20 | 20 | 20 | 40 | 30 | 20 | 10 |
| *Monadenia (M.) fidelis ochromphalus* | | 70 | 20 | 10 | 0 | 50 | 40 | 10 | 0 | 50 | 40 | 10 | 0 | 40 | 40 | 20 | 0 | 20 | 30 | 30 | 20 | 40 | 20 | 20 | 20 | 40 | 20 | 20 | 20 |
| *Monadenia (M.) fidelis pronotis* | O | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Monadenia (M.) fidelis salmonensis* | | 70 | 20 | 10 | 0 | 50 | 30 | 20 | 0 | 60 | 30 | 10 | 0 | 50 | 30 | 20 | 0 | 40 | 30 | 20 | 10 | 40 | 30 | 20 | 10 | 40 | 30 | 30 | 0 |
| *Monadenia (M.) rotifer* | O | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Monadenia (M.) scottiana* | | 60 | 20 | 10 | 10 | 50 | 20 | 20 | 10 | 50 | 20 | 20 | 10 | 40 | 20 | 20 | 20 | 30 | 20 | 20 | 30 | 40 | 20 | 20 | 20 | 40 | 20 | 20 | 20 |
| *Monadenia (M.) setosa* | | 60 | 30 | 10 | 0 | 40 | 30 | 20 | 10 | 40 | 30 | 30 | 0 | 40 | 30 | 20 | 10 | 30 | 30 | 20 | 20 | 40 | 20 | 20 | 20 | 40 | 30 | 20 | 10 |
| *Monadenia (Shastelix) chaceana* | | 60 | 20 | 10 | 10 | 40 | 30 | 20 | 10 | 40 | 40 | 10 | 10 | 30 | 20 | 30 | 20 | 30 | 20 | 20 | 30 | 20 | 20 | 30 | 30 | 20 | 30 | 30 | 20 |
| *Monadenia (S.) churchi* | | 70 | 20 | 10 | 0 | 50 | 20 | 20 | 10 | 40 | 20 | 30 | 10 | 40 | 30 | 20 | 10 | 30 | 30 | 20 | 20 | 30 | 30 | 20 | 20 | 30 | 30 | 20 | 20 |
| *Monadenia (S.) troglodytes troglodytes* | | 60 | 20 | 20 | 0 | 50 | 20 | 20 | 10 | 60 | 20 | 10 | 10 | 30 | 30 | 20 | 20 | 20 | 30 | 30 | 20 | 20 | 30 | 30 | 20 | 20 | 30 | 30 | 20 |
| *Monadenia (S.) troglodytes wintu* | | 60 | 20 | 20 | 0 | 50 | 20 | 20 | 10 | 60 | 20 | 10 | 10 | 30 | 30 | 20 | 20 | 20 | 30 | 30 | 20 | 20 | 30 | 30 | 20 | 20 | 30 | 30 | 20 |
| *Oreohelix n. sp. 1* | | 50 | 30 | 20 | 0 | 40 | 40 | 10 | 10 | 50 | 30 | 10 | 10 | 40 | 30 | 20 | 10 | 40 | 20 | 20 | 20 | 40 | 30 | 20 | 10 | 40 | 30 | 20 | 10 |
| *Pristiloma arcticum crateris* | | 70 | 20 | 10 | 0 | 40 | 30 | 20 | 10 | 50 | 30 | 20 | 0 | 30 | 40 | 20 | 10 | 30 | 30 | 30 | 10 | 30 | 40 | 20 | 10 | 30 | 40 | 20 | 10 |
| *Pristiloma pilsbryi* | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Punctum (Toltecia) hannai* | O | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Trilobopsis roperi* | | 60 | 20 | 10 | 10 | 60 | 10 | 10 | 20 | 50 | 20 | 20 | 10 | 30 | 30 | 30 | 10 | 30 | 20 | 30 | 20 | 30 | 20 | 30 | 20 | 30 | 20 | 30 | 20 |

TABLE 1. MOLLUSC SPECIES AT RISK: VIABILITY RANKINGS UNDER VARIOUS MANAGEMENT OPTIONS.

| Species | Not Rated | Option 1 | | | | Option 3 | | | | Option 4 | | | | Option 5 | | | | Option 7 | | | | Option 8 | | | | Option 9 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | A | B | C | D | A | B | C | D | A | B | C | D | A | B | C | D | A | B | C | D | A | B | C | D | A | B | C | D |
| **LAND SNAILS** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Trilobopsis tehamana* | | 60 | 20 | 10 | 10 | 60 | 10 | 10 | 20 | 50 | 20 | 20 | 10 | 30 | 30 | 30 | 10 | 30 | 20 | 30 | 20 | 30 | 20 | 30 | 20 | 30 | 20 | 30 | 20 |
| *Vertigo n. sp. 1* | | 50 | 20 | 20 | 10 | 30 | 20 | 30 | 20 | 30 | 30 | 30 | 10 | 30 | 30 | 30 | 10 | 30 | 20 | 20 | 20 | 30 | 20 | 20 | 20 | 30 | 20 | 30 | 20 |
| *Vespericola depressa* | | 70 | 20 | 10 | 0 | 40 | 40 | 20 | 0 | 50 | 30 | 20 | 0 | 40 | 30 | 30 | 0 | 30 | 30 | 20 | 20 | 40 | 30 | 20 | 10 | 40 | 30 | 20 | 10 |
| *Vespericola eritrichius* | * | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Vespericola euthales* | O | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Vespericola karokorum* | O | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Vespericola marinensis* | O | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Vespericola n. sp. 1* | O | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Vespericola n. sp. 2* | O | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Vespericola n. sp. 3* | O | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Vespericola pressleyi* | O | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Vespericola shasta* | | 40 | 30 | 30 | 0 | 30 | 30 | 30 | 10 | 40 | 30 | 30 | 0 | 30 | 30 | 30 | 10 | 30 | 30 | 30 | 10 | 30 | 30 | 30 | 10 | 30 | 30 | 30 | 10 |
| *Vespericola sierrana* | | 40 | 30 | 30 | 0 | 50 | 20 | 20 | 10 | 40 | 30 | 30 | 0 | 30 | 30 | 30 | 10 | 30 | 30 | 20 | 20 | 30 | 30 | 30 | 10 | 30 | 30 | 30 | 10 |
| **SLUGS** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Deroceras hesperium* | | 70 | 10 | 10 | 10 | 30 | 40 | 10 | 20 | 40 | 30 | 20 | 10 | 30 | 40 | 10 | 20 | 30 | 20 | 30 | 20 | 30 | 20 | 30 | 20 | 30 | 40 | 10 | 20 |
| *Hemphillia burringtoni* | | 70 | 10 | 10 | 10 | 30 | 40 | 10 | 20 | 40 | 30 | 20 | 10 | 30 | 40 | 10 | 20 | 30 | 20 | 30 | 20 | 30 | 20 | 30 | 20 | 30 | 40 | 10 | 20 |
| *Hemphillia glandulosa* | | 70 | 10 | 10 | 10 | 30 | 40 | 10 | 20 | 40 | 30 | 20 | 10 | 30 | 40 | 10 | 20 | 30 | 20 | 30 | 20 | 30 | 20 | 30 | 20 | 30 | 40 | 10 | 20 |
| *Hemphillia malonei* | | 70 | 20 | 10 | 0 | 30 | 40 | 20 | 10 | 40 | 30 | 20 | 10 | 30 | 20 | 30 | 20 | 30 | 20 | 30 | 20 | 30 | 30 | 20 | 20 | 30 | 30 | 20 | 20 |
| *Hemphillia pantherina* | | 60 | 10 | 20 | 10 | 50 | 30 | 10 | 10 | 50 | 30 | 10 | 10 | 40 | 20 | 20 | 20 | 30 | 30 | 20 | 20 | 30 | 30 | 20 | 20 | 40 | 20 | 20 | 20 |
| *Prophysaon coeruleum* | | 60 | 30 | 10 | 0 | 50 | 20 | 20 | 10 | 50 | 30 | 10 | 10 | 40 | 20 | 20 | 20 | 30 | 20 | 30 | 20 | 40 | 20 | 20 | 20 | 30 | 20 | 30 | 20 |
| *Prophysaon dubium* | | 70 | 20 | 10 | 0 | 50 | 20 | 20 | 10 | 60 | 20 | 20 | 0 | 50 | 20 | 20 | 10 | 40 | 20 | 20 | 20 | 50 | 20 | 20 | 10 | 50 | 20 | 20 | 10 |
| **FRESHWATER SNAILS** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Fisherola nuttalli nuttalli* | | 60 | 20 | 10 | 10 | 40 | 30 | 20 | 10 | 50 | 20 | 20 | 10 | 40 | 20 | 20 | 20 | 30 | 20 | 20 | 30 | 30 | 20 | 30 | 20 | 40 | 20 | 20 | 20 |
| *Fluminicola columbiana* | | 60 | 20 | 10 | 10 | 40 | 30 | 20 | 10 | 50 | 20 | 20 | 10 | 40 | 20 | 20 | 20 | 30 | 20 | 20 | 30 | 30 | 20 | 30 | 20 | 40 | 20 | 20 | 20 |
| *Fluminicola n. sp. 1* | | 60 | 20 | 20 | 10 | 50 | 20 | 20 | 10 | 50 | 20 | 20 | 10 | 40 | 20 | 20 | 20 | 30 | 20 | 30 | 20 | 30 | 20 | 30 | 20 | 40 | 20 | 30 | 10 |
| *Fluminicola n. sp. 2* | | 40 | 20 | 20 | 20 | 30 | 20 | 30 | 20 | 40 | 20 | 20 | 20 | 40 | 20 | 20 | 20 | 20 | 30 | 20 | 30 | 30 | 20 | 30 | 20 | 30 | 20 | 30 | 20 |

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| Species | Not Rated | Option 1 | | | | Option 3 | | | | Option 4 | | | | Option 5 | | | | Option 7 | | | | Option 8 | | | | Option 9 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | A | B | C | D | A | B | C | D | A | B | C | D | A | B | C | D | A | B | C | D | A | B | C | D | A | B | C | D |
| **FRESHWATER SNAILS** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Fluminicola n. sp. 3* | | 50 | 20 | 20 | 10 | 40 | 20 | 20 | 20 | 50 | 20 | 20 | 10 | 30 | 40 | 10 | 20 | 20 | 20 | 30 | 30 | 30 | 40 | 10 | 20 | 30 | 40 | 10 | 20 |
| *Fluminicola n. sp. 4* | | 70 | 20 | 10 | 0 | 50 | 20 | 20 | 10 | 70 | 10 | 10 | 10 | 40 | 20 | 20 | 20 | 20 | 20 | 30 | 30 | 20 | 30 | 30 | 20 | 40 | 10 | 30 | 20 |
| *Fluminicola n. sp. 5* | | 70 | 20 | 10 | 0 | 50 | 20 | 20 | 10 | 70 | 10 | 10 | 10 | 40 | 20 | 20 | 20 | 20 | 20 | 30 | 30 | 20 | 30 | 30 | 20 | 40 | 10 | 30 | 20 |
| *Fluminicola n. sp. 6* | | 70 | 20 | 10 | 0 | 50 | 20 | 20 | 10 | 70 | 10 | 10 | 10 | 40 | 20 | 20 | 20 | 20 | 20 | 30 | 30 | 20 | 30 | 30 | 20 | 40 | 10 | 30 | 20 |
| *Fluminicola n. sp. 7* | | 70 | 20 | 10 | 0 | 50 | 20 | 20 | 10 | 70 | 10 | 10 | 10 | 40 | 20 | 20 | 20 | 20 | 20 | 30 | 30 | 20 | 30 | 30 | 20 | 40 | 10 | 30 | 20 |
| *Fluminicola n. sp. 8* | | 70 | 20 | 10 | 0 | 50 | 20 | 20 | 10 | 70 | 10 | 10 | 10 | 40 | 20 | 20 | 20 | 20 | 20 | 30 | 30 | 20 | 30 | 30 | 20 | 40 | 10 | 30 | 20 |
| *Fluminicola n. sp. 9* | | 70 | 20 | 10 | 0 | 50 | 20 | 20 | 10 | 70 | 10 | 10 | 10 | 40 | 20 | 20 | 20 | 20 | 20 | 30 | 30 | 20 | 30 | 30 | 20 | 40 | 10 | 30 | 20 |
| *Fluminicola n. sp. 10* | | 70 | 20 | 10 | 0 | 50 | 20 | 20 | 10 | 70 | 10 | 10 | 10 | 40 | 20 | 20 | 20 | 20 | 20 | 30 | 30 | 20 | 30 | 30 | 20 | 40 | 10 | 30 | 20 |
| *Fluminicola n. sp. 11* | | 50 | 20 | 20 | 10 | 40 | 20 | 20 | 20 | 50 | 20 | 20 | 10 | 30 | 40 | 10 | 20 | 20 | 20 | 30 | 30 | 30 | 40 | 10 | 20 | 30 | 40 | 10 | 20 |
| *Fluminicola n. sp. 12* | | 40 | 30 | 20 | 10 | 20 | 30 | 30 | 20 | 40 | 30 | 20 | 10 | 20 | 30 | 30 | 20 | 20 | 20 | 30 | 30 | 30 | 30 | 20 | 20 | 20 | 30 | 30 | 20 |
| *Fluminicola n. sp. 13* | | 60 | 10 | 20 | 10 | 40 | 20 | 20 | 20 | 40 | 20 | 30 | 10 | 30 | 30 | 20 | 20 | 30 | 20 | 20 | 30 | 30 | 30 | 20 | 20 | 30 | 30 | 20 | 20 |
| *Fluminicola n. sp. 14* | | 70 | 20 | 10 | 0 | 40 | 20 | 20 | 20 | 50 | 20 | 20 | 10 | 40 | 20 | 20 | 20 | 30 | 20 | 20 | 30 | 30 | 20 | 30 | 20 | 40 | 20 | 20 | 20 |
| *Fluminicola n. sp. 15* | | 70 | 20 | 10 | 0 | 40 | 20 | 20 | 20 | 50 | 20 | 20 | 10 | 40 | 20 | 20 | 20 | 30 | 20 | 20 | 30 | 30 | 20 | 30 | 20 | 40 | 20 | 20 | 20 |
| *Fluminicola n. sp. 16* | | 60 | 20 | 20 | 0 | 40 | 30 | 20 | 10 | 40 | 30 | 30 | 0 | 40 | 30 | 20 | 10 | 30 | 30 | 20 | 20 | 30 | 30 | 20 | 20 | 30 | 30 | 20 | 20 |
| *Fluminicola n. sp. 17* | | 60 | 20 | 20 | 0 | 40 | 30 | 20 | 10 | 40 | 30 | 30 | 0 | 40 | 30 | 20 | 10 | 30 | 30 | 20 | 20 | 30 | 30 | 20 | 20 | 30 | 30 | 20 | 20 |
| *Fluminicola n. sp. 18* | | 70 | 20 | 10 | 0 | 40 | 20 | 20 | 20 | 50 | 20 | 20 | 10 | 40 | 20 | 20 | 20 | 30 | 20 | 20 | 30 | 30 | 20 | 30 | 20 | 40 | 20 | 20 | 20 |
| *Fluminicola n. sp. 19* | | 50 | 10 | 20 | 20 | 30 | 30 | 20 | 20 | 50 | 10 | 20 | 20 | 30 | 20 | 30 | 20 | 20 | 20 | 30 | 30 | 30 | 20 | 30 | 20 | 30 | 20 | 30 | 20 |
| *Fluminicola n. sp. 20* | | 50 | 10 | 20 | 20 | 30 | 30 | 20 | 20 | 50 | 10 | 20 | 20 | 30 | 20 | 30 | 20 | 20 | 20 | 30 | 30 | 30 | 20 | 30 | 20 | 30 | 20 | 30 | 20 |
| *Fluminicola seminalis* | | 70 | 20 | 10 | 0 | 30 | 30 | 20 | 20 | 50 | 20 | 20 | 10 | 30 | 20 | 30 | 20 | 20 | 20 | 30 | 30 | 30 | 20 | 30 | 20 | 30 | 20 | 30 | 20 |
| *Helisoma (Carinifex) newberryi newberryi* | | 70 | 20 | 10 | 0 | 40 | 20 | 30 | 10 | 60 | 30 | 10 | 0 | 40 | 20 | 30 | 10 | 40 | 20 | 10 | 30 | 40 | 20 | 20 | 20 | 40 | 20 | 20 | 20 |
| *Juga (Calibasis) acutifilosa* | | 70 | 20 | 10 | 0 | 50 | 20 | 10 | 20 | 70 | 20 | 10 | 0 | 40 | 10 | 20 | 30 | 40 | 10 | 20 | 30 | 40 | 10 | 30 | 20 | 40 | 10 | 20 | 30 |
| *Juga (C.) occata* | | 70 | 20 | 10 | 0 | 50 | 20 | 10 | 20 | 70 | 20 | 10 | 0 | 50 | 20 | 10 | 20 | 40 | 10 | 20 | 30 | 40 | 20 | 20 | 20 | 40 | 20 | 20 | 20 |
| *Juga (Juga) hemphilli dallesensis* | | 70 | 10 | 10 | 10 | 50 | 20 | 20 | 10 | 70 | 10 | 10 | 10 | 40 | 10 | 30 | 20 | 30 | 20 | 30 | 20 | 30 | 20 | 30 | 20 | 40 | 10 | 30 | 20 |
| *Juga (J.) hemphilli hemphilli* | | 70 | 10 | 10 | 10 | 50 | 20 | 20 | 10 | 70 | 10 | 10 | 10 | 40 | 10 | 30 | 20 | 30 | 20 | 30 | 20 | 30 | 20 | 30 | 20 | 40 | 10 | 30 | 20 |
| *Juga (J.) hemphilli n. subsp. 1* | | 70 | 10 | 10 | 10 | 50 | 20 | 20 | 10 | 70 | 10 | 10 | 10 | 40 | 10 | 30 | 20 | 30 | 20 | 30 | 20 | 30 | 20 | 30 | 20 | 40 | 10 | 30 | 20 |
| *Juga (J.) n. sp. 1* | | 70 | 10 | 10 | 10 | 50 | 20 | 20 | 10 | 70 | 10 | 10 | 10 | 40 | 10 | 30 | 20 | 30 | 20 | 30 | 20 | 30 | 20 | 30 | 20 | 40 | 10 | 30 | 20 |
| *Juga (J.) n. sp. 3* | | 70 | 10 | 10 | 10 | 50 | 20 | 20 | 10 | 70 | 10 | 10 | 10 | 40 | 10 | 30 | 20 | 30 | 20 | 30 | 20 | 30 | 20 | 30 | 20 | 40 | 10 | 30 | 20 |
| *Juga (Oreobasis) chacei* | | 70 | 20 | 10 | 0 | 50 | 20 | 20 | 10 | 60 | 20 | 20 | 0 | 40 | 30 | 20 | 10 | 30 | 30 | 20 | 20 | 40 | 30 | 20 | 10 | 40 | 30 | 20 | 10 |
| *Juga (O.) n. sp. 1* | | 70 | 10 | 10 | 10 | 40 | 20 | 30 | 10 | 50 | 20 | 20 | 10 | 30 | 20 | 30 | 20 | 20 | 20 | 20 | 40 | 40 | 20 | 10 | 30 | 40 | 20 | 20 | 20 |
| *Juga (O.) n. sp. 2* | | 70 | 10 | 10 | 10 | 40 | 20 | 30 | 10 | 50 | 20 | 20 | 10 | 30 | 20 | 30 | 20 | 20 | 20 | 20 | 40 | 40 | 20 | 10 | 30 | 40 | 20 | 20 | 20 |
| *Juga (O.) n. sp. 3* | | 60 | 20 | 20 | 0 | 40 | 30 | 20 | 10 | 40 | 30 | 30 | 0 | 40 | 30 | 20 | 10 | 30 | 30 | 20 | 20 | 30 | 30 | 20 | 20 | 30 | 30 | 20 | 20 |

TABLE 1. MOLLUSC SPECIES AT RISK: VIABILITY RANKINGS UNDER VARIOUS MANAGEMENT OPTIONS.

| Species | Not Rated | Option 1 | | | | Option 3 | | | | Option 4 | | | | Option 5 | | | | Option 7 | | | | Option 8 | | | | Option 9 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | A | B | C | D | A | B | C | D | A | B | C | D | A | B | C | D | A | B | C | D | A | B | C | D | A | B | C | D |
| **FRESHWATER SNAILS** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Juga (O.) orickensis* | | 70 | 20 | 10 | 0 | 50 | 30 | 10 | 10 | 60 | 30 | 10 | 0 | 40 | 30 | 20 | 10 | 30 | 20 | 30 | 20 | 40 | 20 | 20 | 20 | 40 | 30 | 20 | 10 |
| *Lanx alta* | | 70 | 20 | 10 | 0 | 50 | 30 | 10 | 10 | 70 | 20 | 10 | 0 | 40 | 20 | 30 | 10 | 30 | 20 | 20 | 30 | 40 | 20 | 20 | 20 | 40 | 20 | 30 | 10 |
| *Lanx klamathensis* | | 50 | 20 | 20 | 10 | 40 | 20 | 20 | 20 | 50 | 20 | 20 | 10 | 40 | 20 | 20 | 20 | 30 | 20 | 20 | 30 | 30 | 20 | 30 | 20 | 40 | 20 | 20 | 20 |
| *Lanx patelloides* | | 70 | 20 | 10 | 0 | 50 | 20 | 20 | 10 | 60 | 20 | 20 | 0 | 50 | 20 | 20 | 10 | 40 | 20 | 20 | 20 | 50 | 20 | 20 | 10 | 50 | 20 | 20 | 10 |
| *Lanx subrotundata* | | 70 | 20 | 10 | 0 | 50 | 20 | 20 | 10 | 60 | 20 | 20 | 0 | 50 | 20 | 20 | 10 | 40 | 20 | 20 | 20 | 50 | 20 | 20 | 10 | 50 | 20 | 20 | 10 |
| *Lyogyrus n. sp. 1* | | 70 | 10 | 10 | 10 | 40 | 30 | 20 | 10 | 70 | 10 | 10 | 10 | 40 | 10 | 30 | 20 | 30 | 20 | 20 | 30 | 30 | 20 | 30 | 20 | 40 | 10 | 30 | 20 |
| *Lyogyrus n. sp. 2* | | 50 | 20 | 10 | 20 | 40 | 20 | 20 | 20 | 50 | 20 | 10 | 20 | 40 | 20 | 20 | 20 | 30 | 20 | 20 | 30 | 30 | 20 | 30 | 20 | 40 | 20 | 20 | 20 |
| *Lyogyrus n. sp. 3* | | 40 | 30 | 20 | 10 | 30 | 20 | 20 | 30 | 30 | 30 | 20 | 20 | 30 | 20 | 20 | 30 | 20 | 20 | 30 | 30 | 30 | 20 | 20 | 30 | 30 | 20 | 20 | 30 |
| *Lyogyrus n. sp. 4* | | 50 | 20 | 10 | 20 | 30 | 10 | 30 | 30 | 50 | 20 | 10 | 20 | 40 | 20 | 20 | 20 | 30 | 10 | 30 | 30 | 30 | 10 | 30 | 30 | 30 | 20 | 20 | 30 |
| *Lyogyrus n. sp. 5* | | 50 | 20 | 10 | 20 | 30 | 10 | 30 | 30 | 50 | 20 | 10 | 20 | 40 | 20 | 20 | 20 | 30 | 10 | 30 | 30 | 30 | 10 | 30 | 30 | 30 | 20 | 20 | 30 |
| *Lyogyrus n. sp. 6* | | 40 | 20 | 20 | 20 | 30 | 10 | 30 | 30 | 40 | 20 | 20 | 20 | 40 | 20 | 20 | 20 | 20 | 20 | 30 | 30 | 30 | 10 | 30 | 30 | 30 | 20 | 20 | 30 |
| *Physella (Physella) columbiana* | | 30 | 20 | 30 | 20 | 20 | 20 | 30 | 30 | 30 | 20 | 30 | 20 | 20 | 20 | 30 | 30 | 10 | 20 | 30 | 40 | 20 | 20 | 30 | 30 | 20 | 20 | 30 | 30 |
| *Pyrgulopsis archimedis* | | 40 | 20 | 20 | 20 | 30 | 10 | 30 | 30 | 40 | 20 | 20 | 20 | 40 | 20 | 20 | 20 | 20 | 20 | 30 | 30 | 30 | 10 | 30 | 30 | 30 | 20 | 20 | 30 |
| *Pyrgulopsis intermedia* | | 70 | 20 | 10 | 0 | 40 | 20 | 30 | 10 | 70 | 20 | 10 | 0 | 40 | 20 | 30 | 10 | 30 | 20 | 30 | 20 | 40 | 20 | 30 | 10 | 40 | 20 | 30 | 10 |
| *Pyrgulopsis n. sp. 1* | | 40 | 20 | 20 | 20 | 30 | 10 | 30 | 30 | 40 | 20 | 20 | 20 | 40 | 20 | 20 | 20 | 20 | 20 | 30 | 30 | 30 | 10 | 30 | 30 | 30 | 20 | 20 | 30 |
| *Vorticifex klamathensis klamathensis* | | 50 | 20 | 10 | 20 | 30 | 10 | 30 | 30 | 50 | 20 | 10 | 20 | 40 | 20 | 20 | 20 | 30 | 10 | 30 | 30 | 30 | 10 | 30 | 30 | 30 | 20 | 20 | 30 |
| *Vorticifex klamathensis sinitsini* | | 40 | 20 | 20 | 20 | 30 | 10 | 30 | 30 | 40 | 20 | 20 | 20 | 40 | 20 | 20 | 20 | 20 | 20 | 30 | 30 | 30 | 10 | 30 | 30 | 30 | 10 | 30 | 30 |
| *Vorticifex n. sp. 1* | | 40 | 30 | 20 | 10 | 30 | 20 | 20 | 30 | 30 | 30 | 20 | 20 | 30 | 20 | 20 | 30 | 20 | 20 | 30 | 30 | 30 | 20 | 20 | 30 | 30 | 20 | 20 | 30 |
| *Vorticifex neritoides* | | 30 | 20 | 30 | 20 | 20 | 20 | 30 | 30 | 30 | 20 | 30 | 20 | 20 | 20 | 30 | 30 | 10 | 20 | 30 | 40 | 20 | 20 | 30 | 30 | 20 | 20 | 30 | 30 |
| **FRESHWATER CLAMS** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Anodonta californiensis* | | 50 | 30 | 10 | 10 | 30 | 30 | 20 | 20 | 40 | 30 | 20 | 10 | 30 | 30 | 20 | 20 | 10 | 30 | 30 | 30 | 30 | 30 | 20 | 20 | 30 | 30 | 20 | 20 |
| *Anodonta wahlametensis* | | 40 | 30 | 10 | 20 | 30 | 30 | 20 | 20 | 40 | 30 | 20 | 10 | 30 | 30 | 20 | 20 | 10 | 30 | 30 | 30 | 30 | 30 | 20 | 20 | 30 | 30 | 20 | 20 |
| *Pisidium (Cyclocalyx) ultramontanum* | | 70 | 20 | 10 | 0 | 40 | 20 | 30 | 10 | 60 | 20 | 20 | 0 | 40 | 20 | 20 | 20 | 30 | 20 | 10 | 40 | 40 | 10 | 30 | 20 | 40 | 20 | 20 | 20 |

Explanation:

X= not enough information to evaluate; generally very rare and/or endemic taxon not collected recently

O= rating to be done by Barry Roth

*= may not occur on federal lands

Options and Outcomes are defined in the ADDENDUM appendices

TABLE 2. SUMMARY OF PROPOSED MANAGEMENT OPTIONS.

WORKING DOCUMENT
PREDECISIONAL
NOT SUBJECT TO FOIA

| | Summary of the Options | | | | | | |
|---|---|---|---|---|---|---|---|
| | Option 1 | Option 3 | Option 4 | Option 5 | Option 7 | Option 8 | Option 9 |
| Late-Successional Reserves million acres | 11.405 | 7.910 | 8.235 | 6.691 | 5.740 | 7.517 | Not yet tallied |
| Timber harvest/salvage Late-Successional Reserves | None | Treatment of forest stands less than 50 years old.<br>Very limited salvage | Treatment of forest stands less than 80 years old.<br>Limited salvage | Same as Option 4 | Same as Option 4 | Treatment of forest stands up to 180 years old.<br>Full salvage | West - Treatment of forest stands less than 80 years old.<br>East - 50 percent retention. Long rotation or uneven-age management |
| Managed Late-Successional Areas million acres | 0 | 0.939 | 0.147 | 0.147 | 0.147 | 0 | 0 |
| Timber harvest/Salvage Managed Late-Successional Areas | N/A | 50 percent retention<br>West-Long rotation.<br>East-Long rotation, or uneven-age management | Maintain over 50 percent retention in Late-Successional Reserves. Condition variable techniques. | Same as Option 4 | Same as Option 4 | N/A | N/A |
| Riparian Reserves million acres | 1.870 | 1.950 | 2.881 | 2.400 | 0.619 | Not yet tallied | Not yet tallied |
| Buffer widths | Full SAT all watersheds | Full SAT key watersheds with aquatic conservation emphasis<br>1/2 SAT other watersheds | Same as Option 1 | Same as Option 3 | Variable usually less than 1/2 SAT - No buffers on intermittent | 1/6 SAT all watersheds | Same as Option 3 |
| Matrix million acres | 2.921 | 4.760 | 4.355 | 5.962 | 8.485 | Not yet tallied | Not yet tallied |
| Snags per acre | 2 | Amount to support 40 percent pop. level of primary cavity species. | Variable usually less than two on National Forests. BLM - 2. | Same as Option 4 | Same as Option 4 | Same as Option 4 | Coastal areas WA/OR: 2. Other areas retention or long rotation. |
| Logs per acre | 2 | West 12 - East 2-10 | Variable on National Forests (0-20). BLM - 2. | Same as Option 4 | Same as Option 4 | Same as Option 4 | Coastal areas WA/OR: 2. Other areas retention or long rotation. |
| Green trees per acre | 6 | 4 | Variable National Forest - usually less than 2. BLM-2. | Same as Option 4 | Same as Option 4 | Same as Option 4 | Coastal areas WA/OR: 2. Other areas retention or long rotation. |
| 50-11-40 | Yes | Yes | Yes | Yes | Yes | No | No |
| Protection for sites occupied by marbled murrelets outside reserves | Yes | Yes | Yes | Yes | No | No | No |
| Protection of SAT species closely associated with old-growth | Yes | Yes | Yes | Yes | No | No | Yes |
| Adminstratively Withdrawn Areas million acres | 1.081 | 1.685 | 1.660 | 2.079 | 2.286 | Not yet tallied | Not yet tallied |

# APPENDIX 1. DESCRIPTION OF MANAGEMENT OPTIONS.

OPTION 1

WORKING DOCUMENT
PREDECISIONAL
NOT SUBJECT TO FOIA

**LATE-SUCCESSIONAL RESERVES:**

Timber Harvest: None

Salvage: None

**MANAGED LATE-SUCCESSIONAL AREAS:** None

Timber Harvest: N/A

Salvage: N/A

**RIPARIAN RESERVES:**

Buffer widths - All Key Watersheds and all other waterheds:

Fish Bearing Streams, lakes, reservoirs - the height of 2 site potential trees (340-480 feet) or 300 feet (whichever is greater)on each side of the stream.

Permanently flowing non-fish bearing streams, ponds, wetlands less than 1 acre - height of a site potential tree (170-240 feet) or 150 feet (whichever is greater) on each side of the stream.

Intermittent streams, wetlands less than 1 acre - height of a site potential tree (170-240 feet) or 100 feet (whichever is greater) on each side of the stream.

Management Prescription:

Prohibit timber harvest; manage roads to reduce sediment delivery to streams; modify grazing practices to reduce impacts; limit mining impacts

**THE MATRIX:**

Green Tree Retention: 6 larger than average stand diameter per acre.

Snags: 2 per acre

Logs: 2 per acre

Other Features:

50-11-40 rule plus 180 year timber harvest rotations plus another 10 % of the matrix to be in forest stands over 180 years old in the future. 50-11-40 calls for 50% of a 1/4 township (Federal lands) to be in forest stands that average at least and 11 inches dbh and have a canopy closure of at least 40%.

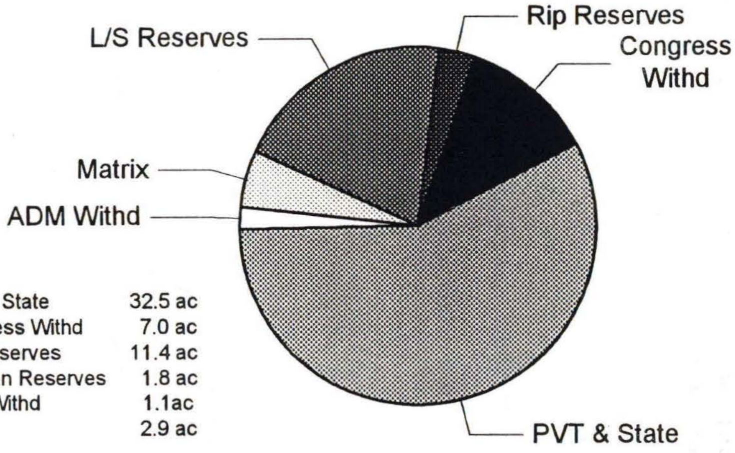
Protection of rare and locally endemic species associated with late successional forests based on Thomas et al. (1993).

# Option 1

All Areas are within Range of the Northern Spotted Owl
(All Values are in Millions of Acres)

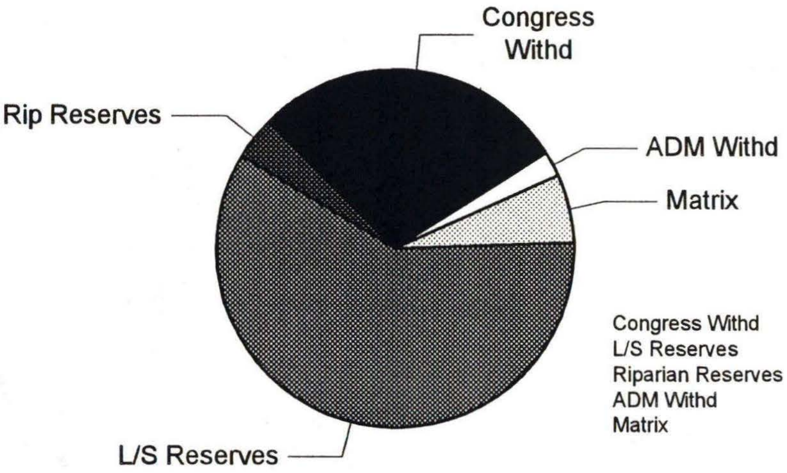
**WORKING DOCUMENT**
**PREDECISIONAL**
**NOT SUBJECT TO FOIA**

### Total Area
### 56.733 Million Acres



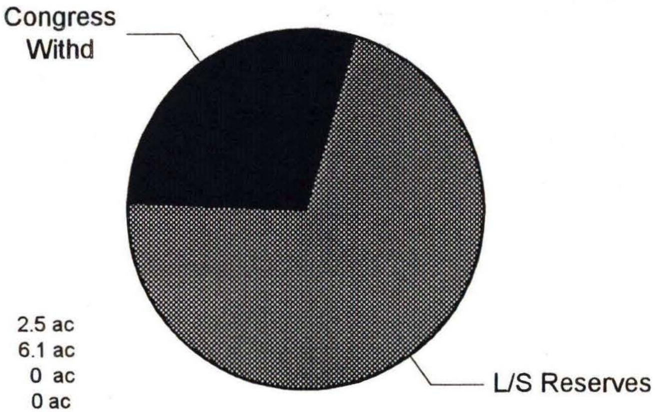
| | |
|---|---|
| PVT & State | 32.5 ac |
| Congress Withd | 7.0 ac |
| L/S Reserves | 11.4 ac |
| Riparian Reserves | 1.8 ac |
| ADM Withd | 1.1ac |
| Matrix | 2.9 ac |

### Federal Forests over 9in DBH
### 14.3 Million Acres



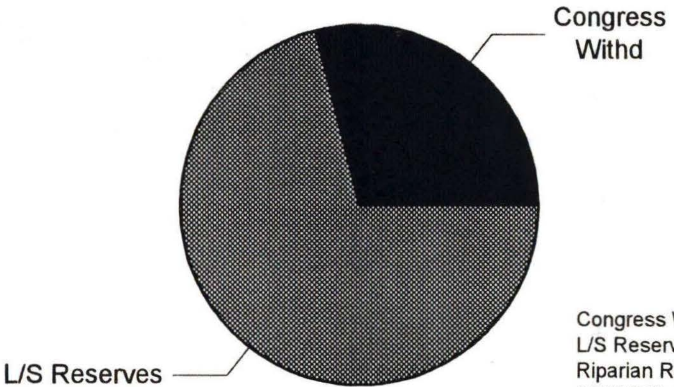
| | |
|---|---|
| Congress Withd | 4.1 ac |
| L/S Reserves | 8.4 ac |
| Riparian Reserves | .6 ac |
| ADM Withd | .3 ac |
| Matrix | .9 ac |

### Federal Forests over 21in DBH
### 8.512 Million Acres



| | |
|---|---|
| Congress Withd | 2.5 ac |
| L/S Reserves | 6.1 ac |
| Riparian Reserves | 0 ac |
| ADM Withd | 0 ac |
| Matrix | 0 ac |

### Federal Multi-story Forests over 21 in DBH
### 4.498 Million Acres



| | |
|---|---|
| Congress Withd | 1.3 ac |
| L/S Reserves | 3.2 ac |
| Riparian Reserves | 0 ac |
| ADM Withd | 0 ac |
| Matrix | 0 ac |

WORKING DOCUMENT
PREDECISIONAL
NOT SUBJECT TO FOIA

LATE-SUCCESSIONAL RESERVES:

Timber Harvest: Cutting primarily limited to precommercial and commercial thinning of forest stands less than 50 years old that have been established following logging. The objective of such harvest is to accelerate the development of late-successional conditions. Proposals for treatment of naturally regenerated stands or stands older than 50 years require approval of an interagency oversight team.

Salvage: Limited to removal of dead trees in areas of catastrophic loss that exceed 100 acres where no live trees or snags over 20 inches in diameter can be cut. Only a portion of the down trees can be removed. The percentage to be calculated based on local conditions that provide for coarse woody debris at levels found in natural fire induced stands.

MANAGED LATE-SUCCESSIONAL AREAS:

Timber Harvest: Western portions of the range of the northern spotted owl.

50% of the area to be retained per Late-Successional Reserves. Selection of the 50% to be based on occupancy by spotted owls, marbled murrelets, protection of fish bearing and intermittent streams and sites occupied by other species associated with late-successional forests.

Cutting will be based on 250 year rotations and proceed only if the Managed Late-Successional Area has more than 40% of the area in forest stands over 100 years old. Six (6) of the largest green trees will be left on each acre that is cut.

Salvage: Within the areas to be managed on 250 year rotations, salvage would be allowed. Within the 50% to be reserved, salvage consistent with the objectives for the Late-Successional Reserves is allowed.

Timber Harvest: Eastern portions of the range of the northern spotted owl. (Eastern Cascade of Oregon and Washington and California Cascades.)

50% of the area to be retained per Late-Successional Reserves. Selection of the 50% to be based on occupancy by spotted owls, marbled murrelets, protection of fish bearing and intermittent streams and sites occupied by other species associated with late-successional forests.

Cutting of other stands will be based on either 250-350 year rotations or uneven-aged management and proceed only if the Managed Late-Successional Area has more than 40% of the area in forest stands over 80 years old. Emphasis for cutting is to reduce the risk of catastrophic fire and insect infestations. Six (6) of the largest green trees will be left on each acre that is cut.

Salvage: Within the areas to be managed on an uneven-aged basis or under 250-350 year rotations, salvage would be allowed. Within the 50% to be reserved, salvage consistent with the objectives for the Late-Successional Reserves is allowed.

WORKING DOCUMENT
PREDECISIONAL
NOT SUBJECT TO FOIA

Option 3 continued:

### RIPARIAN RESERVES:

Buffer widths - Key Watersheds with aquatic conservation emphasis:

Fish Bearing Streams, lakes, reservoirs - the height of 2 site potential trees (340-480 feet) or 300 feet (whichever is greater) on each side of the stream..

Permanently flowing non-fish bearing streams, ponds, wetlands less than 1 acre - height of a site potential tree (170-240 feet) or 150 feet (whichever is greater) on each side of the stream.

Intermittent streams, wetlands less than 1 acre - height of a site potential tree (170-240 feet) or 150 feet (whichever is greater) on each side of the stream.

Buffer widths - Key Watersheds with water quality emphasis and all other watersheds:

Fish Bearing Streams, lakes, reservoirs - the height of 2 site potential trees (340-480 feet) or 300 feet (whichever is greater) on each side of the stream..

Permanently flowing non-fish bearing streams, ponds, wetlands less than 1 acre - height of a site potential tree (170-240 feet) or 150 feet (whichever is greater) on each side of the stream.

Intermittent streams, wetlands less than 1 acre - 1/2 height of a site potential tree (170-240 feet) or 50 feet (whichever is greater) on each side of the stream.

Management Prescription:

Prohibit timber harvest; manage roads to reduce sediment delivery to streams; modify grazing practices to reduce impacts; limit mining impacts

### THE MATRIX:

Green Tree Retention: 4 large green trees per acre.

Snags: numbers to support 40 percent of potential population of primary cavity nesting species.

Logs: 12 per acre in western portion; 2-10 in eastern part of range.

Other Features:

50-11-40 rule; plus retention of 10% of the Matrix area in late-successional forest stands (or the oldest available).

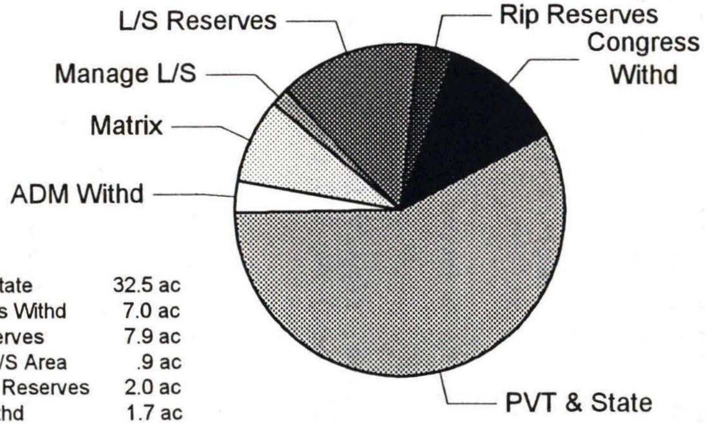
Protection of rare and locally endemic species associated with late successional forests based on Thomas et al. (1993).

# Option 3

**All Areas are within Range of the Northern Spotted Owl**
**(All Values are in Millions of Acres)**

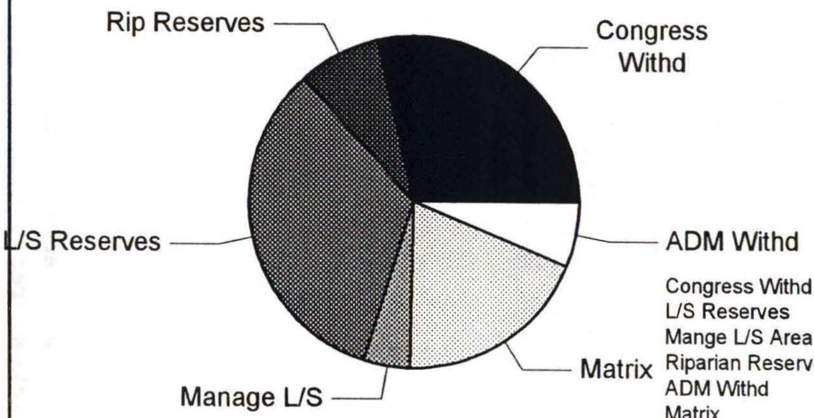
WORKING DOCUMENT
PREDECISIONAL
NOT SUBJECT TO FOIA

## Total Area
## 56.733 Million Acres



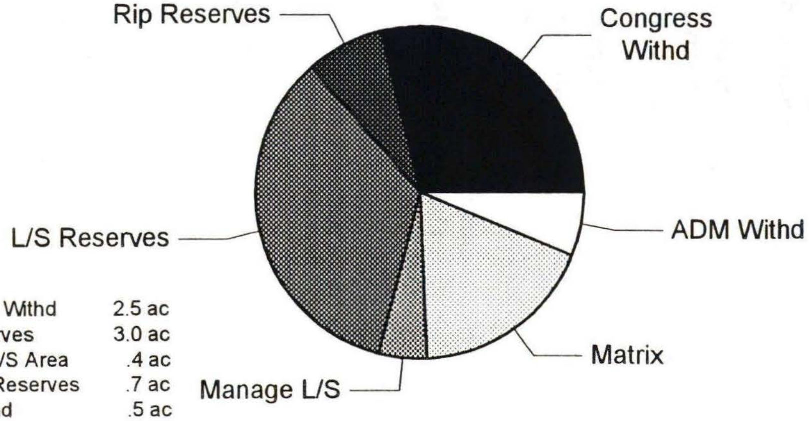
| | |
|---|---|
| PVT & State | 32.5 ac |
| Congress Withd | 7.0 ac |
| L/S Reserves | 7.9 ac |
| Mange L/S Area | .9 ac |
| Riparian Reserves | 2.0 ac |
| ADM Withd | 1.7 ac |
| Matrix | 4.8 ac |

## Federal Forests over 9in DBH
## 14.3 Million Acres



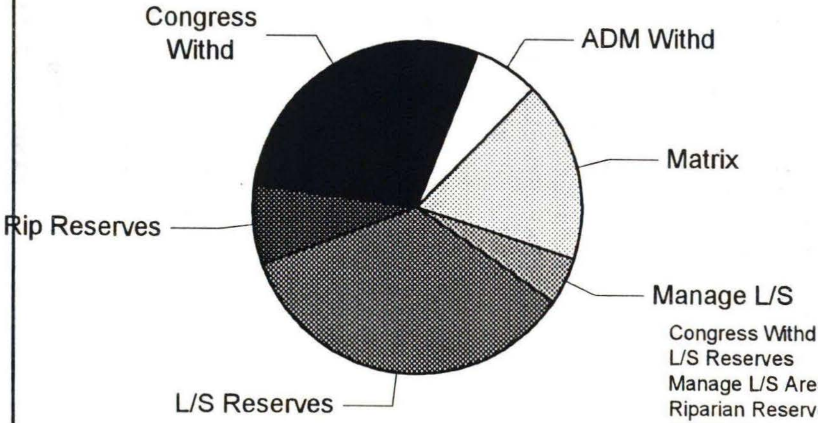
| | |
|---|---|
| Congress Withd | 4.1 ac |
| L/S Reserves | 4.8 ac |
| Mange L/S Area | .6 ac |
| Riparian Reserves | 1.2 ac |
| ADM Withd | .9 ac |
| Matrix | 2.7 ac |

## Federal Forests over 21in DBH
## 8.512 Million Acres



| | |
|---|---|
| Congress Withd | 2.5 ac |
| L/S Reserves | 3.0 ac |
| Manage L/S Area | .4 ac |
| Riparian Reserves | .7 ac |
| ADM Withd | .5 ac |
| Matrix | 1.6 ac |

## Federal Multi-story Forests over 21 in DBH
## 4.498 Million Acres



| | |
|---|---|
| Congress Withd | 1.3 ac |
| L/S Reserves | 1.6 ac |
| Manage L/S Area | .2 ac |
| Riparian Reserves | .3 ac |
| ADM Withd | .3 ac |
| Matrix | .8 ac |

WORKING DOCUMENT
PREDECISIONAL
NOT SUBJECT TO FOIA

### LATE-SUCCESSIONAL RESERVES:

Timber Harvest: Based on precommercial and commercial thinning of younger stands designed to accelerate the development of late-successional conditions. This will consist primarily of treating younger forest stands (younger than 80 years). Proposals for variance will have to be reviewed by an interagency oversight team.

Salvage: Limited to removal of dead trees in areas of catastrophic loss that exceed 10 acres where no live trees or snags over 20 inches in diameter can be cut. Only a portion of the down trees can be removed. The percentage to be calculated based on local conditions that provide coarse woody debris at levels found in natural fire induced stands.

### MANAGED LATE-SUCCESSIONAL AREAS:

**Timber Harvest: These areas should be maintained so that more than 50 percent of the area is composed of late-successional forests. A range of management techniques may be used to accomplish the objective and reduce risk of fire and insect infestations.**

Salvage: Removal of trees consistent with the provisions for timber harvest is allowed.

### RIPARIAN RESERVES:

Buffer widths - Key Watersheds with aquatic conservation emphasis:

Fish Bearing Streams, lakes, reservoirs - the height of 2 site potential trees (340-480 feet) or 300 feet (whichever is greater) on each side of the stream..

Permanently flowing non-fish bearing streams, ponds, wetlands less than 1 acre - height of a site potential tree (170-240 feet) or 150 feet (whichever is greater) on each side of the stream.

Intermittent streams, wetlands less than 1 acre - height of a site potential tree (170-240 feet) or 150 feet (whichever is greater) on each side of the stream.

Buffer widths - Key Watersheds with water quality emphasis and all other watersheds:

Fish Bearing Streams, lakes, reservoirs - the height of 2 site potential trees (340-480 feet) or 300 feet (whichever is greater) on each side of the stream..

Permanently flowing non-fish bearing streams, ponds, wetlands less than 1 acre - height of a site potential tree (170-240 feet) or 150 feet (whichever is greater) on each side of the stream.

Intermittent streams, wetlands less than 1 acre - height of a site potential tree ((170-240 feet) or 100 feet (whichever is greater) on each side of the stream.

Management Prescription:

Prohibit timber harvest; manage roads to reduce sediment delivery to streams; modify grazing practices to reduce impacts; limit mining impacts.

Option 4 continued:

**THE MATRIX:**

Green Tree Retention: Variable by National Forest usually less than 2 per acre. BLM - 6-9 per acre

Snags: Variable by National Forest usually less than 2 per acre. BLM - 2 per acre.

Logs: Variable by National Forest (none to 20 ). BLM - 2 per acre.

Other Features:

50-11-40 rule.

Protection of rare and locally endemic species associated with late successional forests based on Thomas et al. (1993).

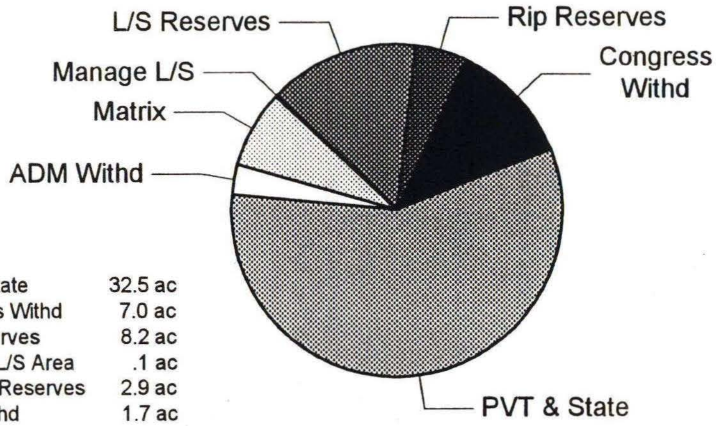
WORKING DOCUMENT
PREDECISIONAL
NOT SUBJECT TO FOIA

# Option 4

All Areas are within Range of the Northern Spotted Owl
(All Values are in Millions of Acres)

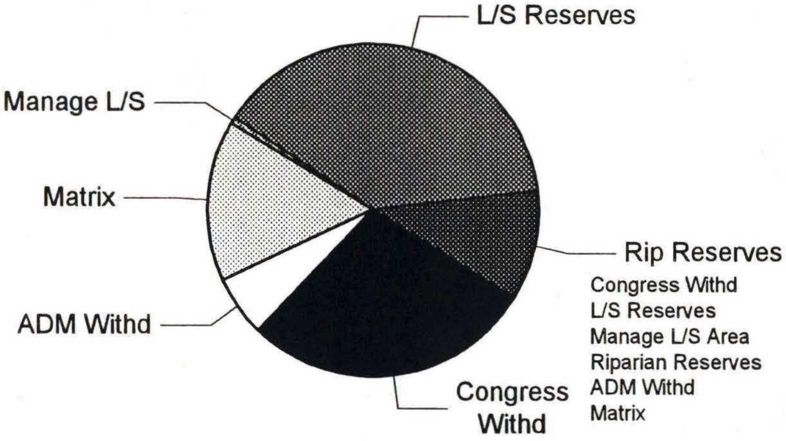
WORKING DOCUMENT
PREDECISIONAL
NOT SUBJECT TO FOIA

## Total Area
## 56.733 Million Acres



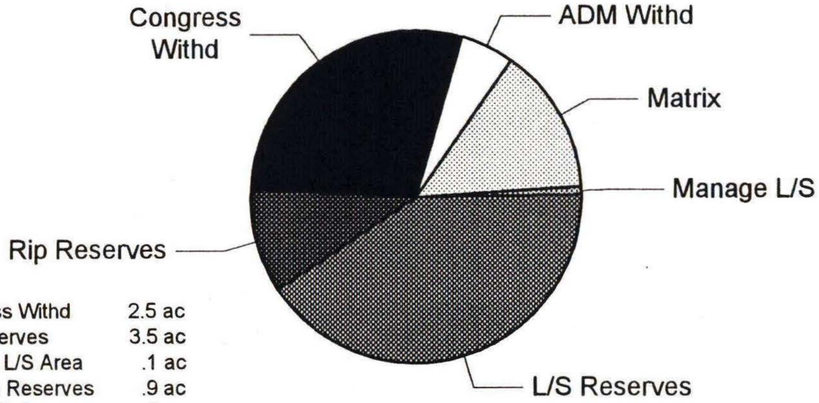
| | |
|---|---|
| PVT & State | 32.5 ac |
| Congress Withd | 7.0 ac |
| L/S Reserves | 8.2 ac |
| Manage L/S Area | .1 ac |
| Riparian Reserves | 2.9 ac |
| ADM Withd | 1.7 ac |
| Matrix | 4.4 ac |

## Federal Forests over 9in DBH
## 14.3 Million Acres



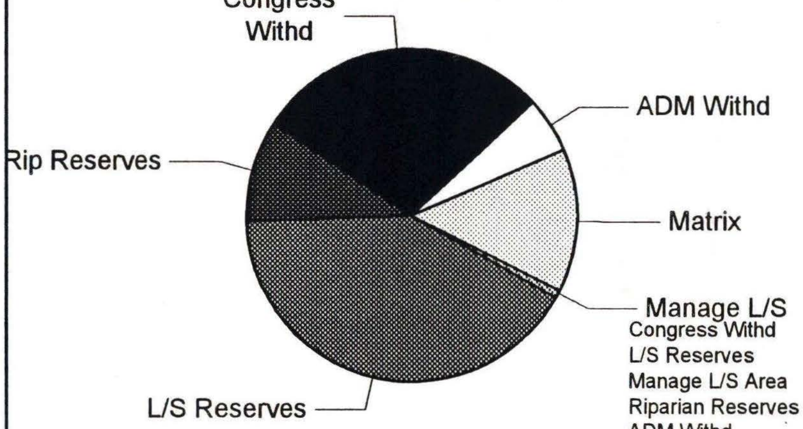
| | |
|---|---|
| Congress Withd | 4.1 ac |
| L/S Reserves | 5.6 ac |
| Manage L/S Area | .1 ac |
| Riparian Reserves | 1.5 ac |
| ADM Withd | .9 ac |
| Matrix | 2.2 ac |

## Federal Forests over 21in DBH
## 8.512 Million Acres



| | |
|---|---|
| Congress Withd | 2.5 ac |
| L/S Reserves | 3.5 ac |
| Manage L/S Area | .1 ac |
| Riparian Reserves | .9 ac |
| ADM Withd | .5 ac |
| Matrix | 1.2 ac |

## Federal Multi-story Forests over 21 in DBH
## 4.498 Million Acres



| | |
|---|---|
| Congress Withd | 1.3 ac |
| L/S Reserves | 1.9 ac |
| Manage L/S Area | .03 ac |
| Riparian Reserves | .4 ac |
| ADM Withd | .3 ac |
| Matrix | .6 ac |

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## LATE-SUCCESSIONAL RESERVES:

Timber Harvest: Based on precommercial and commercial thinning of younger stands designed to accelerate the development of late-successional conditions. This will consist primarily of treating younger forest stands (younger than 80 years). Proposals for variance will have to be reviewed by an interagency oversight team.

Salvage: Limited to removal of dead trees in areas of catastrophic loss that exceed 10 acres where no live trees or snags over 20 inches in diameter can be cut. Only a portion of the down trees can be removed. The percentage to be calculated based on local conditions that provide for coarse woody debris at levels found in natural fire induced stands.

## MANAGED LATE-SUCCESSIONAL AREAS:

Timber Harvest: These areas should be maintained so that more than 50 percent of the area is composed of late-successional forests. A range of management techniques may be used to accomplish the objective and reduce risk of fire and insect infestations.

Salvage: Removal of trees consistent with the provisions for timber harvest is allowed.

## RIPARIAN RESERVES:

Buffer widths - Key Watersheds with aquatic conservation emphasis:

Fish Bearing Streams, lakes, reservoirs - the height of 2 site potential trees (340-480 feet) or 300 feet (whichever is greater) on each side of the stream..

Permanently flowing non-fish bearing streams, ponds, wetlands less than 1 acre - height of a site potential tree (170-240 feet) or 150 feet (whichever is greater) on each side of the stream.

Intermittent streams, wetlands less than 1 acre - height of a site potential tree (170-240 feet) or 150 feet (whichever is greater) on each side of the stream.

Buffer widths - Key Watersheds with water quality emphasis and all other watersheds:

Fish Bearing Streams, lakes, reservoirs - the height of 2 site potential trees (340-480 feet) or 300 feet (whichever is greater) on each side of the stream..

Permanently flowing non-fish bearing streams, ponds, wetlands less than 1 acre - height of a site potential tree (170-240 feet) or 150 feet (whichever is greater) on each side of the stream.

Intermittent streams, wetlands less than 1 acre - 1/2 height of a site potential tree (170-240 feet) or 50 feet (whichever is greater) on each side of the stream.

Management Prescription:

Prohibit timber harvest; manage roads to reduce sediment delivery to streams; modify grazing practices to reduce impacts; limit mining impacts.

Option 5 continued:

THE MATRIX:

Green Tree Retention: Variable by National Forest usually less than 2 per acre. BLM - 6-9 per acre

Snags: Variable by National Forest usually less than 2 per acre. BLM - 2 per acre.

Logs: Variable by National Forest (none to 20 ). BLM - 2 per acre.

Other Features:

50-11-40 rule.

Protection of rare and locally endemic species associated with late successional forests based on Thomas et al. (1993).

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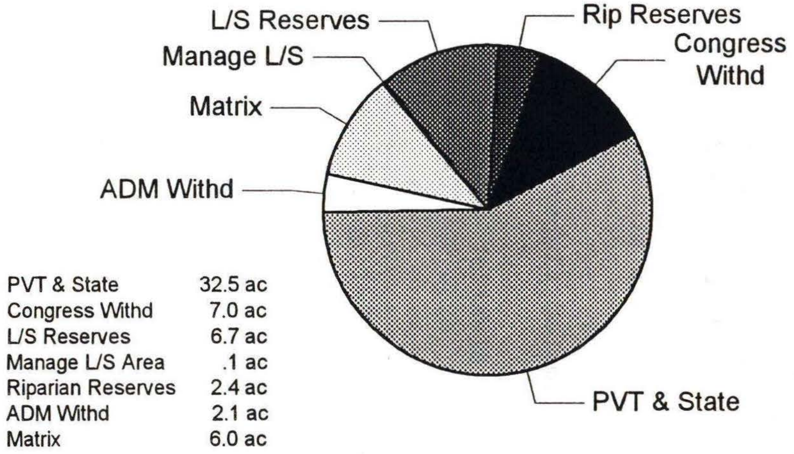
# Option 5

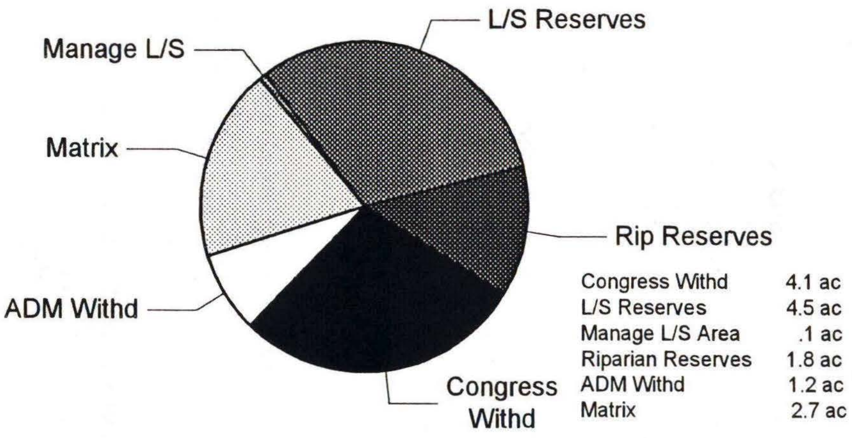
**All Areas are within Range of the Northern Spotted Owl**
**(All Values are in Millions of Acres)**

### Total Area
### 56.733 Million Acres



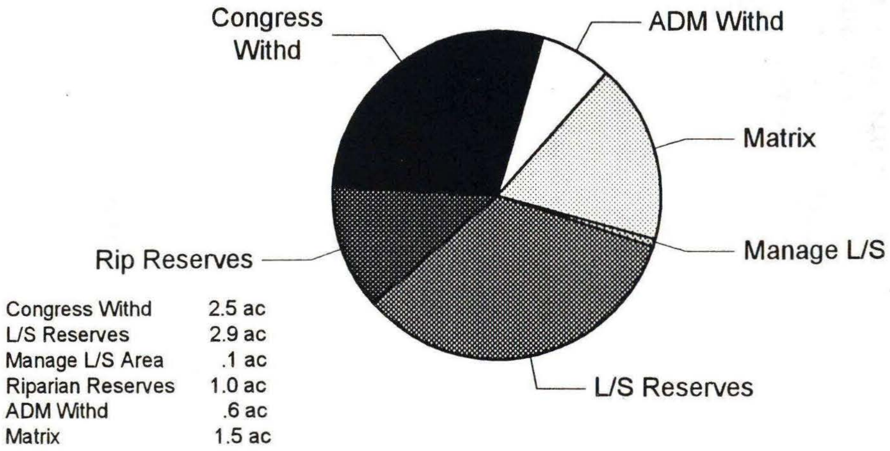
| | |
|---|---|
| PVT & State | 32.5 ac |
| Congress Withd | 7.0 ac |
| L/S Reserves | 6.7 ac |
| Manage L/S Area | .1 ac |
| Riparian Reserves | 2.4 ac |
| ADM Withd | 2.1 ac |
| Matrix | 6.0 ac |

### Federal Forests over 9in DBH
### 14.3 Million Acres



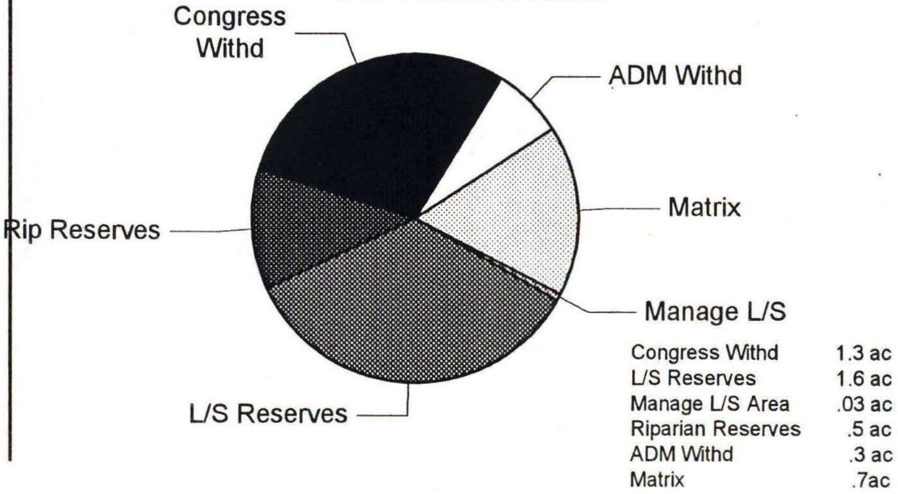
| | |
|---|---|
| Congress Withd | 4.1 ac |
| L/S Reserves | 4.5 ac |
| Manage L/S Area | .1 ac |
| Riparian Reserves | 1.8 ac |
| ADM Withd | 1.2 ac |
| Matrix | 2.7 ac |

### Federal Forests over 21in DBH
### 8.512 Million Acres



| | |
|---|---|
| Congress Withd | 2.5 ac |
| L/S Reserves | 2.9 ac |
| Manage L/S Area | .1 ac |
| Riparian Reserves | 1.0 ac |
| ADM Withd | .6 ac |
| Matrix | 1.5 ac |

### Federal Multi-story Forests over 21 in DBH
### 4.498 Million Acres



| | |
|---|---|
| Congress Withd | 1.3 ac |
| L/S Reserves | 1.6 ac |
| Manage L/S Area | .03 ac |
| Riparian Reserves | .5 ac |
| ADM Withd | .3 ac |
| Matrix | .7ac |

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LATE-SUCCESSIONAL RESERVES:

Timber Harvest: Based on precommercial and commercial thinning of younger stands designed to accelerate the development of late-successional conditions. This will consist primarily of treating younger forest stands (younger than 80 years). Proposals for variance will have to be reviewed by an interagency oversight team.

Salvage: Limited to removal of dead trees in areas of catastrophic loss that exceed 10 acres where no live trees or snags over 20 inches in diameter can be cut. Only a portion of the down trees can be removed. The percentage to be calculated based on local conditions that provide for coarse woody debris at levels found in natural fire induced stands.

MANAGED LATE-SUCCESSIONAL AREAS:

Timber Harvest: These areas should be maintained so that more than 50 percent of the area is composed of late-successional forests. A range of management techniques may be used to accomplish the objective and reduce risk of fire and insect infestations.

Salvage: Removal of trees consistent with the provisions for timber harvest is allowed.

RIPARIAN RESERVES:

Buffer widths - Based on the levels established in the Forest Service and BLM land management plans. Widths are variable--generally slightly less than the widths provided in the other options for fish bearing streams and permanently flowing non-fish bearing streams. There are usually no buffers prescribed for the intermittent streams--where they are prescribed they are 25 feet on each side of the stream.

Management Prescription:

Variable--often permit limited timber harvest in the form of long rotations or salvage.

THE MATRIX:

Green Tree Retention: Variable by National Forest usually less than 2 per acre. BLM - 6-9 per acre

Snags: Variable by National Forest usually less than 2 per acre. BLM - 2 per acre.

Logs: Variable by National Forest (none to 20 ). BLM - 2 per acre.

Other Features:

50-11-40 rule.

## OPTION 8

**LATE-SUCCESSIONAL RESERVES:** NO GRAPHS BUT TOTAL AMOUNT - 7.50 MILLION ACRES

Timber Harvest: Cutting prescribed for forest stands up to 150 years old. Protection of forest stands over 150 years old. Objective is to produce or maintain spotted owl habitat.

Salvage: No restrictions.

**MANAGED LATE-SUCCESSIONAL AREAS:** None

Timber Harvest: N/A

Salvage: N/A

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**RIPARIAN RESERVES:**

Buffer widths - all watersheds.

Fish Bearing Streams, lakes, reservoirs - the height of 2 site potential trees (340-480 feet) or 300 feet (whichever is greater) on each side of the stream..

Permanently flowing non-fish bearing streams, ponds, wetlands less than 1 acre - 1/2 height of a site potential tree (170-240 feet) or 75 feet (whichever is greater) on each side of the stream.

Intermittent streams, wetlands less than 1 acre - 1/6 height of a site potential tree (170-240 feet) or 25 feet (whichever is greater) on each side of the stream.

Management Prescription:

Prohibit timber harvest; manage roads to reduce sediment delivery to streams; modify grazing practices to reduce impacts; limit mining impacts

**THE MATRIX:**

Green Tree Retention: Variable by National Forest usually less than 2 per acre. BLM - 6-9 per acre

Snags: Variable by National Forest usually less than 2 per acre. BLM - 2 per acre.

Logs: Variable by National Forest (none to 20 ). BLM - 2 per acre.

Other Features: None

# Option 7

All Areas are within Range of the Northern Spotted Owl
(All Values are in Millions of Acres)

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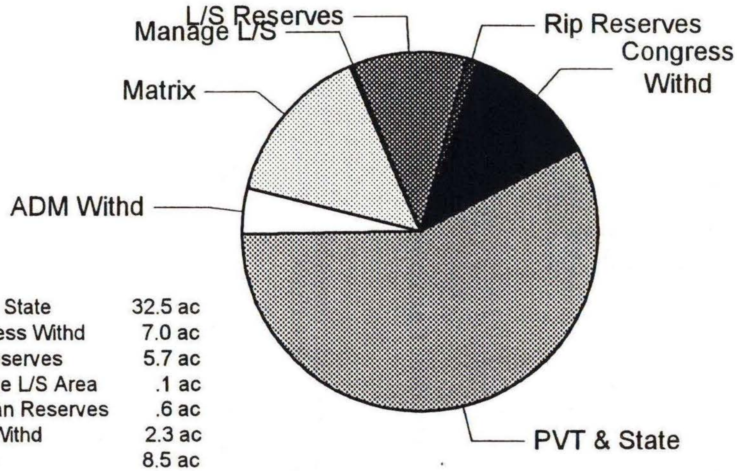
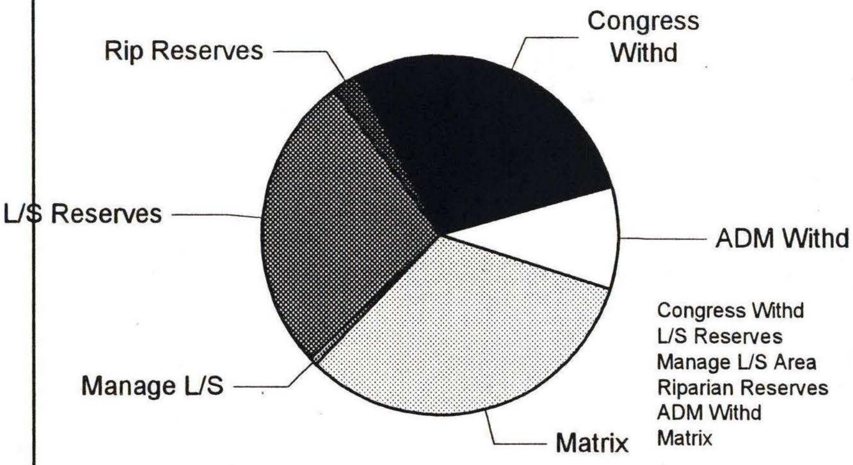
## Total Area
56.733 Million Acres



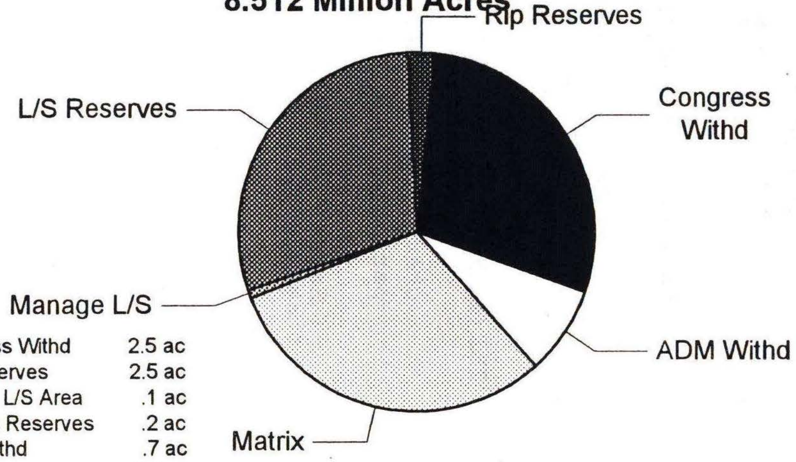
| | |
|---|---|
| PVT & State | 32.5 ac |
| Congress Withd | 7.0 ac |
| L/S Reserves | 5.7 ac |
| Manage L/S Area | .1 ac |
| Riparian Reserves | .6 ac |
| ADM Withd | 2.3 ac |
| Matrix | 8.5 ac |

## Federal Forests over 9in DBH
14.3 Million Acres



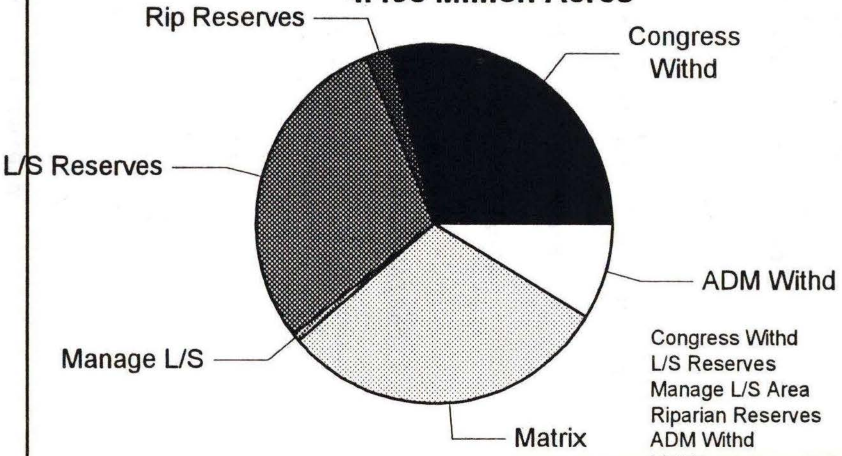
| | |
|---|---|
| Congress Withd | 4.1 ac |
| L/S Reserves | 3.9 ac |
| Manage L/S Area | .1 ac |
| Riparian Reserves | .3 ac |
| ADM Withd | 1.3 ac |
| Matrix | 4.6 ac |

## Federal Forests over 21in DBH
8.512 Million Acres



| | |
|---|---|
| Congress Withd | 2.5 ac |
| L/S Reserves | 2.5 ac |
| Manage L/S Area | .1 ac |
| Riparian Reserves | .2 ac |
| ADM Withd | .7 ac |
| Matrix | 2.6 ac |

## Federal Multi-story Forests over 21 in DBH
4.498 Million Acres



| | |
|---|---|
| Congress Withd | 1.3 ac |
| L/S Reserves | 1.3 ac |
| Manage L/S Area | .03 ac |
| Riparian Reserves | .1 ac |
| ADM Withd | .4 ac |
| Matrix | 1.4 ac |

OPTION 9

**LATE-SUCCESSIONAL RESERVES:** AMOUNT UNKNOWN LIKELY BETWEEN OPTIONS 5 AND 8.

Timber Harvest: Western portion of the range of the northern spotted owl.

Precommercial and commercial thinning of forest stands (both natural and those regenerated after logging) up to the point such stands attain late-successional conditions (generally 80 years old). The objective of such harvest is to accelerate the development of late-successional conditions. The effect of the harvest must be neutral or beneficial with respect to late-successional conditions.

Salvage: Western portion of the range of the northern spotted owl - Individual projects will be considered based on a process that includes review by an interagency oversight team.

Timber Harvest: Eastern portions of the range of the northern spotted owl. (Eastern Cascades of Oregon and Washington and California Cascades.)

50% of the area to be retained per Late-Successional Reserves. Selection of the 50% to be based on occupancy by spotted owls, marbled murrelets, protection of fish bearing and intermittent streams and sites occupied by other species associated with late-successional forests.

Cutting of other stands will be based on either 250-350 year rotations or uneven-aged management and proceed only if the Managed Late-Successional Area has more than 40% of the area in forest stands over 80 years old. Emphasis for cutting is to reduce the risk of catastrophic fire and insect infestations.

No ponderosa pine trees or western larch trees 21 inches dbh or greater will be cut.

Salvage: Eastern portion of the range of the northern spotted owl - Within the areas to be managed on an uneven-aged basis or under 250-350 year rotations, salvage would be allowed as in the Late-Successional Reserves. Within the 50% to be reserved, salvage consistent with the objectives for the Late-Successional Reserves is allowed.

**MANAGED LATE-SUCCESSIONAL AREAS:** None

Timber Harvest: N/A

Salvage: N/A

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Adaptive Management Areas:

Areas where ecological, social, and economic objectives are integrated. Separate objectives are established for each area. See separate handout for description of the objectives.

Option 9 continued

RIPARIAN RESERVES: AMOUNT UNKNOWN - LIKELY BETWEEN OPTION 5 AND OPTION 8 IN TOTAL AMOUNT.

Buffer widths - Key Watersheds with aquatic conservation emphasis:

Fish Bearing Streams, lakes, reservoirs - the height of 2 site potential trees (340-480 feet) or 300 feet (whichever is greater) on each side of the stream..

Permanently flowing non-fish bearing streams, ponds, wetlands less than 1 acre - height of a site potential tree (170-240 feet) or 150 feet (whichever is greater) on each side of the stream.

Intermittent streams, wetlands less than 1 acre - height of a site potential tree (170-240 feet) or 150 feet (whichever is greater) on each side of the stream.

Buffer widths - Key Watersheds with water quality emphasis and all other watersheds:

Fish Bearing Streams, lakes, reservoirs - the height of 2 site potential trees (340-480 feet) or 300 feet (whichever is greater) on each side of the stream..

Permanently flowing non-fish bearing streams, ponds, wetlands less than 1 acre - height of a site potential tree (170-240 feet) or 150 feet (whichever is greater) on each side of the stream.

Intermittent streams, wetlands less than 1 acre - 1/2 height of a site potential tree (170-240 feet) or 50 feet (whichever is greater) on each side of the stream.

Management Prescription:

Prohibit timber harvest; manage roads to reduce sediment delivery to streams; modify grazing practices to reduce impacts; limit mining impacts

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Option 9 continued:

## THE MATRIX:

For The Oregon Coast Range and the Olympic Peninsula provinces and the Mt. Baker-Snoqualmie National Forest:

Green Tree Retention: None

Snags: 2 per acre

Logs: 2 per acre

For the rest of the National Forests in Oregon and Washington within the range of the northern spotted owl:

Retention of 15% of the area to be harvested; at least 1/2 of that is to be left in small (1/2 to 4 acre) patches of intact late successional forests or the next oldest stand available. The remaining 1/2 is to be left in green trees dispersed throughout the unit.

For BLM administered lands in northern Oregon (north of Grant's Pass):

Management is based on providing 640 acre blocks of land (spaced 3-5 miles apart) that are managed on 150 year timber harvest rotations. When an area is cut,12-18 green trees will be retained. Overall 25-30% of the block must be in late successional forest at any point in time.

For BLM administered lands in southern Oregon (south of Grant's Pass):

Management consists of selective harvest where 16-25 large green trees per acre are left.

For the Federal forests in California:

180 year harvest rotations for conifer and mixed evergreen forests and 100 years for hardwood forests.

Other Features:

Protection of rare and locally endemic species associated with late successional forests based on Thomas et al. (1993).

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# APPENDIX 2. RANKING SCALE.

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# VIABILITY RATING SCALES

June 2, 1993

Expert panels will be used to assess the likely effects of various management options on species or groups of species. (For the remainder of this discussion, the term species will be used to mean either the individual species that is being rated or the group of species that are being rated). The experts will be asked to estimate the likelihood that habitat provided on federal land within the range of the northern spotted owl will be adequate to allow the species to exist, well-distributed across the portion of that range that it occupies for the next 100 years.

## Rating scale

To make their assessments, panelists will be asked to distribute 100 "likelihood" votes among four possible future outcomes for each species. These outcomes describe conditions that could exist for the species' habitat, and the species, on federal land at the end of 100 years. The descriptions follow:

> Outcome A Habitat is of sufficient quality, distribution and abundance to allow the species population to stabilize, well-distributed across federal lands. (Note that the concept of well-distributed must be based on knowledge of the species distribution, range and life history--see discussion below on the concept of well-distributed).
>
> Outcome B Habitat is of sufficient quality, distribution and abundance to allow the species population to stabilize, but with significant gaps in the historic species distribution. These gaps cause some limitation in interactions among local populations. (Note that the significance of gaps must be judged relative to the species distribution, range and life history and the concept of metapopulations--see discussion below on the concept of well-distributed).

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Outcome C  Habitat only allows continued species existence in refugia, with strong limitations on interactions among local populations.

Outcome D  Habitat conditions result in species extirpation from federal land.

Judgement about these outcomes is to be based on habitat conditions on federal land, and species responses to those conditions. Thus, it must consider the current condition of the population and possible low points in habitat and population that would occur within the 100 year period. If the species would not be expected to survive the low point in a well-distributed condition, the panelists' voting among the outcomes should reflect that expectation.

Description of four possible outcomes on federal lands based on habitat conditions provided by various options

| OUTCOMES | Population level | Distribution | Population interactions |
|---|---|---|---|
| A | continued existence | well-distributed | yes |
| B | continued existence | gaps | some limitations |
| C | continued existence | only in refugia | severely restricted |
| D | extirpation | NA | NA |

**Factors considered in judgements**

The judgement will be based only on the effects that habitat on federal land will have on the species. Panelists will be asked to assume that conditions other than habitat on federal land are adequate to provide for well-distributed, stabilized

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populations. These factors include environmental conditions other than habitat condition (e.g., ocean pollution); habitat conditions on non-federal land; land ownership patterns; and the amount of overlap between the species range and the range of the spotted owl. These factors will be brought back into the assessment in a later step, but should not influence the initial rating. For example, the overall likelihood of supporting viable populations of marbled murrelets will be strongly influenced by ocean conditions and by habitat conditions on non-federal lands. However, in the initial rating we are asking the panelists to only assess the likelihood that nesting habitat on federal land will be adequate to support well-distributed populations of murrelets on federal land. In a subsequent step, we will ask panelists to describe the likely effects of other factors.

In making their judgemets, panelists should consider all the information that is provided concerning the options under consideration. This will include both mapped and tabular information. When the ratings are made, we ask that panelists describe the particular features of options that have the greatest influence on their judgements. We define these features as follows:

Riparian reserves proposed for the option

Specific distances protected for different stream classes
Overall acreage of the reserves
Distribution of the reserves across the landscape
Management proposed for the reserves
Quality of habitat within the reserves

Other reserves proposed for the option

Overall acreage of the reserves
Size of the individual reserves
Location of specific reserves
Spacing of the reserves
Distribution of the reserves across the landscape

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Management proposed for the reserves
Quality of habitat within the reserves

Forests in the matrix
Overall amount of forest in the matrix
Distribution of matrix lands across the landscape
Proposed managment provisions of the matrix forests

In discussing their ratings, panelists are asked to cite those factors that most influenced their judgements, both positively and negatively.

Panelists should consider both the natural history characteristics of the species, and the likely changes in habitat when making judgements. In thinking about habitat, they should consider successional patterns and the likelihood of both small-scale and large-scale natural disturbances.

### Definition of well-distributed

The need to consider whether a species is or is not well-distributed comes from a variety of sources including the regulations for the National Forest Management Act. However, there is no clear definition of the term, particularly when it is applied to a variety of taxa. In general, it has been interpreted to mean that portions of the species population would not become isolated subpopulations. For spotted owls, well-distributed has been interpreted as the maintenance of a metapopulation consisting of many local populations that are expected to interact through dispersal of individuals. In this case, the local populations are distributed throughout the range, but there are reasonably large areas within the range that are sparsely populated or not populated at all. This seems to be a reasonable interpretation of what constitutes a well-distributed population of a species that can disperse long distances.

For species with more limited habitat, the definition of well-distributed must take

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into account the normal distribution of habitat. For example, Del Norte salamanders occur on talus slopes protected by overstory canopies that maintain cool, moist conditions on the ground. They would never become widely distributed throughout the landscape. Such a species ought to be considered well-distributed if (1) a reasonably large percentage of its potential habitat sites remain occupied and (2) management does not create significant dispersal barriers that would isolate populations.

Still different definitions of well-distributed might be appropriate for other species with extremely limited movement capabilities. Examples could include lichens and fungi that could take decades to expand their distribution from one stand to another. Even under natural disturbances, such species may have been absent from large portions of their range at any point in time. For these species, it might be argued that a well-distributed condition is one in which there is potential for them to occupy most parts of the landscape on at least a cyclic basis.

### Species for which there is little information

Prior to the development of ratings for any given species, panelists are asked to consider whether knowledge of that species is adequate to allow a judgement. This is a difficult call since we do not have absolute knowledge for any species and there is uncertainty involved in all of the judgements. We can not, in a straightforward manner, describe the degree of uncertainty that makes it impossible to provide a credible rating. This judgement is left to the panelists. In making it, they must consider the following:

- How much is known about the species distribution?
- How much is known about species habitat associations and relative abundance in different habitats?
- How much is known about actual population levels and trends?

After consideration of these questions, the panelists must decide if there is enough information to allow an informed judgement. We would prefer that panels come to concensus on this question, but will make allowance for a situation where individual panelists decide not to participate in a particular rating.

### Rare and locally endemic species

Panelists are asked to identify species that are rare, locally endemic, or otherwise expected to respond to conditions at a scale that can not be considered in a regional assessment. These species will be rated, because it may be possible to identify some options that provide for them better than others. However, they will also be clearly identified, and the locations where mitigation would be necessary will be identified.

### Differential response in different parts of the range

For some species in some options, responses will vary from one part of the range to another. For these species, the range will be divided for purposes of the assessment. Some of these divisions have already been made on the rating form, but others can be made if the need for them is identified by the panel.

### Other influences on viability

For many species, viability will be significantly influenced by factors other than the condition of habitat on federal land. Panelists will be asked to identify those factors from a menu of possible choices. The choices are:

> Land ownership patterns - some species occur largely on nonfederal lands within the range of the spotted owl, so federal land management will not be the major determinant of their viability.
>
> Range not coincident with spotted owls - some species occur in ranges that only partly overlap the spotted owl's range, so management within the range of the owl is not the major determinant of their viability.
>
> Other environmental conditions caused by activities off federal lands - some species are significantly influenced by factors other than the condition of

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forested habitats. An example would be the influence of at sea conditions on marbled murrelets.

In most cases, panelists will be asked only to identify these factors, and not to provide a second viability rating based on their consideration. For a few species, such as murrelets, a separate viability rating may be desired.

## Mitigation

Panelists will be asked to identify possible mitigation measures for all options that do not produce an 80% likelihood of achieving outcome A. Mitigations should be site specific wherever possible. Panelists will be asked to identify the degree to which the mitigations would be expected to improve outcomes. In general, a minimum goal for mitigation would be to raise the likelihood of outcome A to 80% or higher. If the only possible mitigation is the choice of another option, then mitigation does not have to be described.